SUMMARY OF RESEARCH - FY83

RESEARCH SECTION

DIVISION OF PLANNING AND PROGRAMMING

ALASKA

DEPARTMENT OF TRANSPORTATION

AND PUBLIC FACILITIES

July 1983

Daniel A. Casey	Commissioner
H. Glenzer, Jr.	Deputy Commissioner, Northern Region
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FOREWORD

A National Science Foundation publication contained the following statement:

> One-third of the growth in the national income during the post-war period flowed from advances in knowledge, particularly in the sciences and the new technologies to which they give rise.

The message stated here is that change, growth, and improvements in living conditions are a result of continually probing to find a better way to do things. The implementation of the results of applied research into standard usage flows from many years of basic research in universities and other similar organizations, through the applied technology channels, and finally into daily life.

The responsibilities of the Department of Transportation and Public Facilities are broad, encompassing aviation, highways, ports, harbors, marine transportation systems, state schools, and nearly all other public buildings.

It was recently reported that on a nationwide basis, the annual expenditures for transportation related research are approximately one-twenty-fifth of the similar expenditures in high technology fields and only one-fifth of the expenditures in low technology fields.

The distances involved and the environmental and economic conditions encountered in Alaska cannot be equalled in any other state. For this reason, it is important for the State of Alaska to maintain a research involvement to test new products and experiment with new technologies.

Larry Sweet
Research Manager

SECTION 1
OBJECTIVE

The Department of Transportation and Public Facilities has the mission of planning, building, and maintaining the greater portion of the transportation systems and state-owned facilities in Alaska. This complex task requires special knowledge of the unique Alaskan environment in a variety of technical disciplines.

The Research Section, within the Division of Planning and Programming was created to support the technical framework of the operational divisions of the Department on a statewide basis. The objective of the Section is to develop new technical knowledge to improve the Department's capability to carry out the assigned mission. The goals of the Research Section are to reduce costs, improve efficiency, and increase serviceability of state facilities and transportation systems by better understanding the materials and methods and the environment in which they are used.

Research is performed by staff engineers, consultants in the private sector, university faculty, and other government agencies.

At the present time the Research Section is engaged in a broad spectrum of investigations that include highways, buildings and energy-related problems, transportation systems research, airport and aviation investigations, and ports and harbors.

SECTION 2
RESEARCH IN PROGRESS

SUMMARY OF RESEARCH PROJECTS

HIGHWAY RESEARCH PROGRAM

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. McHattie/ Woodward-Clyde Consultants	Highway Life Cycle Costing	State	2 years 9/82
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Stabilized Soils Study	State	3 years 6/83
R. McHattie/ Oregon State University	Resilient Soil Properties Study	State	3 years 12/82
D. Esch/ Petroleum Engineering Department, University of Alaska	Snow and Ice Control Study	State	3 years 12/82
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Permafrost Culvert Study	State	3 years 6/83
B. Connor/ Boeing Computer Services Washington State DOT	Engineering Computer Software	State	3 years 6/83
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Pavement Thermal Study	State	3 years 6/83
B. Connor/ Shannon & Wilson, Inc.	Roadway Strength Inventory	State	2 years 6/83
D. Esch/ School of Mineral Industry, University of Alaska	Frost Heave Test Development	State	3 years 12/83
R. McHattie/ Geophysical Institute, University of Alaska	Low Temperature Thermal Cracking	State	2 years 6/83
B. Connor/ Geophysical Institute, University of Alaska	Thermal Analysis Computer Modeling	State	3 years 12/83

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
B. Connor/ Mechanical Engineering Department, University of Alaska	Solar-Assisted Culvert Thawing Devices	State	3 years 2/83
D. Esch	Prethawing of Permafrost by Surface Modifications	FHWA	3 years 6/82
R. Jurick, R. McHattie/ Geophysical Institute, University of Alaska	Field Evaluation Site for Ground Ice Detection	FHWA	2 years 10/82
S. Kailing/ Institute of Water Resources, University of Alaska	Fish Passage Through Drainage Structures	FHWA	3 years 6/84
S. Kailing/ Institute of Water Resources, University of Alaska	Aspects of Streamflow with Regard to Fish Passage	FHWA	2 years 6/84
R. McHattie/ Shannon & Wilson, Inc.	Correlating Dynamic Deflections with Pavement Performance	FHWA	2 years 12/82
B. Connor/ Mechanical Engineering Department, University of Alaska	Evaluation of Air Duct Ground Stabilization System	FHWA	2 years 12/82
R. Jurick, R. McHattie/ Geophysical Institute, University of Alaska	Geophysical Methods for Detecting Permafrost and Ground Ice	FHWA	2 years 10/82
D. Esch/ Civil Engineering Department, University of Alaska Bell, Herring & Assoc.	Permafrost Research Site Monitoring	FHWA	2 years 6/83
D. Esch, E. Johnson	Applications of Engineering Fabrics in Alaska	FHWA	3 years 12/82
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory Civil Engineering Department, University of Alaska	Ice Forces on Northern River Bridges	FHWA	4 years 6/82
R. McHattie/ Oregon State University	Mechanistic Design Methods for Alaskan Pavements	FHWA	2 years 9/82
D. Esch/ Geophysical Institute and Civil Engineering Department, University of Alaska	Portable Powered Probe for Permafrost	FHWA	1 year 6/82

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
D. Esch, F. Narusch	Rubberized Asphalt for Roadway Ice Control	FHWA	3 years 7/82
D. Esch	Soil Stabilization for Remote Area Roads	FHWA	2 years 5/82
R. McHattie	Evaluation of Road Rater Test Methods	FHWA	2 years 8/82
R. McHattie, M. Reckard	Economic Aspects of High Speed Unpaved Roads	FHWA	2 years 9/82
D. Esch/ Civil Engineering Department, University of Alaska	Design Guide for Pavements Over Permafrost	FHWA	2 years 6/82
D. Esch/ Civil Engineering Department, University of Alaska	Design Manual for Roadways Over Muskeg	FHWA	2 years 6/82
D. Esch/ Civil Engineering Department, University of Alaska	Stress Monitoring of New Gastineau Channel Bridge	FHWA	3 years 6/83
B. Connor/ Geophysical Institute, University of Alaska	Remote Monitoring of Springtime Thaw Depths	FHWA	2 years 6/83
D. Esch/ Geophysical Institute, University of Alaska	4th International Conference on Permafrost	FHWA	3 years 6/84
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Bridge Construction on Permafrost	FHWA	2 years 6/83
C. Gentry/ Harding Lawson, Inc. VECO, Inc.	Use of Preheated Maintenance Sand for Skid Control	FHWA	2 years 3/84
C. Gentry/ USKH Consultants, Inc.	Highway Thaw/Settlement Control	FHWA	2 years 6/84
R. McHattie	Evaluation of AC-1.75 Asphalt	FHWA	2 years 6/84
B. Connor	Decision Criteria for Seal Coating	FHWA	2 years 6/83
D. Esch	Pile Frost Jacking Study	State	2 years 7/84

ENERGY AND BUILDINGS RESEARCH PROGRAM

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Jurick, J. Rezek/ Institute of Water Resources & Mechanical Engineering Department, University of Alaska Janet Matheson, Architect, Inc. J.S. Strandberg Consulting Engineers Charles Bettisworth & Company Fairbanks North Star Borough	Passive Solar Alaskan School	U.S.D.O.E. & State	4 years 2/84
J. Rezek, J. Strid	Moist Insulation Study	State	2 years 12/83
R. Jurick, J. Rezek	DOTPF Communications	State	2 years 6/84
J. Rezek, D. Ketner	Building Failures Survey	State	2 years 12/84
L. Leonard/ Mechanical Engineering Department, University of Alaska J.S. Strandberg Consulting Engineers Crews, MacInnes & Hoffman, Engineering Consultants	Thermal Performance Standards for State Buildings	State	3 years 6/84
L. Leonard, L. Hegdal, J. Rezek, S. Kailing/ Mechanical Engineering Department, University of Alaska J.S. Strandberg Consulting Engineers Sunfair Engineering, Inc.	Buildings Energy Conservation Studies	State	2 years Ongoing
L. Hegdal	Thermal Load Simulation for Small Buildings (F-LOAD)	State	3 years Ongoing
J. Rezek/ Mechanical Engineering Department, University of Alaska	Insulation Shape Factors	State	1 year
J. Rezek, L. Leonard	Public Facilities Design Standards Review	State	2 years Ongoing
S. Kailing/ Mechanical Engineering Department, University of Alaska	Furnace Efficiency	State	2 years
J. Rezek	Architectural Materials Testing	State	2 years

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
J. Rezek/ Mechanical Engineering Department, University of Alaska J.S. Strandberg Consulting Engineers	Metal Stud Walls	State	1 year
R. Jurick, L. Leonard, S. Kailing/ Mechanical Engineering and Electrical Engineering Departments, University of Alaska J.S. Strandberg Consulting Engineers	Remote Facilities Monitoring	State	3 years 12/83
R. Jurick, L. Leonard	Rural Electric Power Quality	State	2 years
R. Jurick, L. Hegdal/ J.S. Strandberg Consulting Engineers	Freeze-Up Alarms	State	2 years
S. Kailing, R. Jurick	Monitoring of Heat Generation Equipment	State	2 years
L. Leonard/J. Malosh	Fuel Cell Evaluation	State	3 years 6/83
J. Rezek/D. Ketner	Roofing Design and Materials Investigation	State	2 years 6/83
S. Kailing/ Alaska Department of Environmental Conservation	Vehicle Emission - Effects on Air Quality	State	3 years 6/83
S. Kailing	Public Facilities Building Codes	State	2 years 6/83
L. Hegdal	Public Building Life Cycle Costing	State	2 years 12/82
L. Hegdal, L. Leonard	Utility Freeze Protection	State	3 years 12/83
S. Kailing	Building Air Quality	State	2 years 6/84

TRANSPORTATION SYSTEMS RESEARCH PROGRAM

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Miller, L. Leonard/ Ormat Systems	Noorvik Airport Lighting Demonstration	State/ FAA	3 years 9/83
R. Miller/ Woodward-Clyde Consultants	Paint Performance Testing	State	3 years 6/83
R. Miller, R. Tanner, L. Sweet/ Peratrovich, Nottingham & Drage, Inc. Geophysical Institute, Univ. of Alaska Corps of Engineers	Transportation Research Projects	State	2 years 6/83
R. Miller/ The Boeing Company	Alternate Transportation Modals	State	2 years 6/83
R. Miller/ U.S. Maritime Administration Arctec, Inc.	Ice Breaker Trafficability Studies, Phase V	State	1 year 6/83
R. Miller, B. Allison	Aircraft Hydroplaning Prevention	State	3 years 12/83
R. Miller	Automated Weather Reporting Demonstration	State	2 years 12/83
R. McHattie/ Oregon State University	Asphalt Aggregate Specifications, Phase I	State	2 years 12/83
R. Miller/ Peratrovich, Nottingham & Drage	Breakwater Monitoring	State	1 year 6/83
S. Powers, C. Tillman	Bridge Deck Repair Techniques	State	3 years 12/84
R. Miller/ Peratrovich, Nottingham & Drage	Corrosion Research, Phase II	State	1 year 12/83
R. Miller/ Geophysical Institute, University of Alaska	Earthquake Hazards	State	1 year 6/83
R. Miller	Effective Corrosion Protection	State	1 year 12/83
R. Miller, C. Siebe	Passive Refrigeration	State	2 years 12/83
L. Leonard, L. Hegdal/ U.S. Department of Energy	Radio Isotope Illuminators	State	1 year 6/83

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
C. Gentry/ Battelle Alaska	Remote Airfield Stabilization, Phase I	State	2 years 12/83
R. Miller, L. Leonard, L. Hegdal	Rural Airport Edge Lighting	State	3 years 12/84

SECTION 2
RESEARCH ABSTRACTS

HIGHWAY RESEARCH PROGRAM

Highway Life Cycle Costing - Recent developments in the field of highway management have been directed toward the evaluation of total "Life Cycle" costs. This approach utilizes new computerized design techniques to assess the serviceability and longevity of various construction and maintenance alternatives. Construction, maintenance, and those user costs functionally related to pavement quality are then combined into a complete life cycle analysis. The overall effect of life cycle costing is to minimize the total construction, maintenance, and user expenditures, thereby providing a net savings to the people of the state. The results of this study by consultant Woodward-Clyde were published as reports AK-RD-83-5, "Life Cycle Costing of Paved Alaskan Highways, Volume 1," and AK-RD-83-6, "Life Cycle Costing of Paved Alaskan Highways - User Manual."

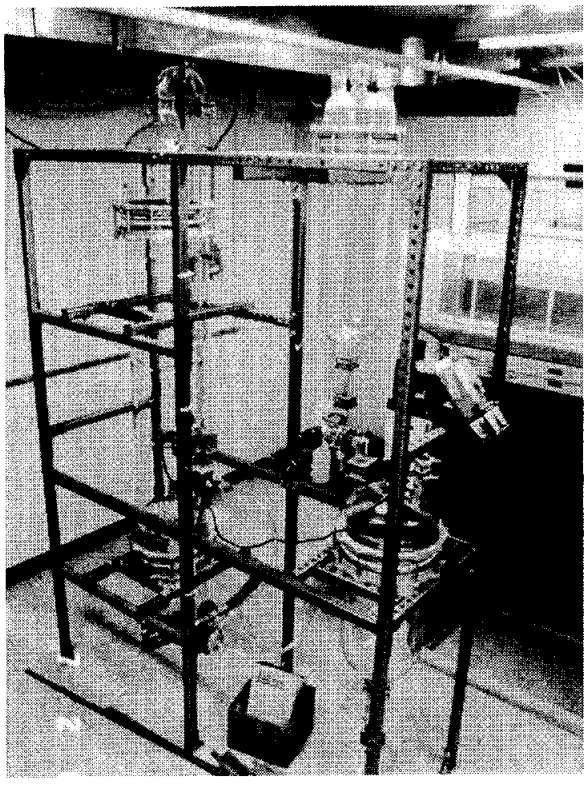
Stabilized Soils Study - Asphalt emulsions were evaluated in the Department's Research laboratory for reducing frost heaving and moisture segregation in silty gravel roadway bases and subbase materials and for bonding of organic silty sands. A separate study is underway at the Cold Regions Research and Engineering Laboratory on stabilizers for sandy organic silts. If durable mixes can be developed, frost-susceptible silty gravels and even organic sandy silts could be used with stabilization chemicals in place of the clean sands and gravels normally required in highway and airfield pavement structures.

For areas of Alaska where suitable materials are not available, major savings in construction costs should result from this study. Final report completions are anticipated for the summer of 1983.

Resilient Soil Properties Study - This study will determine the resilient modulus values of a full range of Alaskan highway construction materials and identify and quantify the factors controlling their resilient behavior. A number of existing pavements and recent pavement designs are being evaluated to determine condition and performance potential. A new

testing system is being installed, and operators are being trained to perform modulus tests that will be used to analyze the performance of Alaska's roadway pavement structures. This should improve future pavement design methods.

Snow and Ice Control Study - In the Maintenance Section of the Department approximately $10,000,000 is spent annually on snow and ice control on pavements. This expense is only to keep the roads open and safe for the traveling public and adds nothing to the overall improvement of the system. Since this cost represents approximately 20% of the total maintenance budget, significant savings can be realized by establishing the most improved, cost-effective methods for controlling snow and ice problems. This study is investigating various aspects of snow and ice control to develop new techniques and policies. Specific projects included under this funding program include snow fence construction and evaluations at Thompson Pass, sand-ice friction evaluation studies, benefit of chip seals for increased traction, and culvert icing control studies using solar panels.

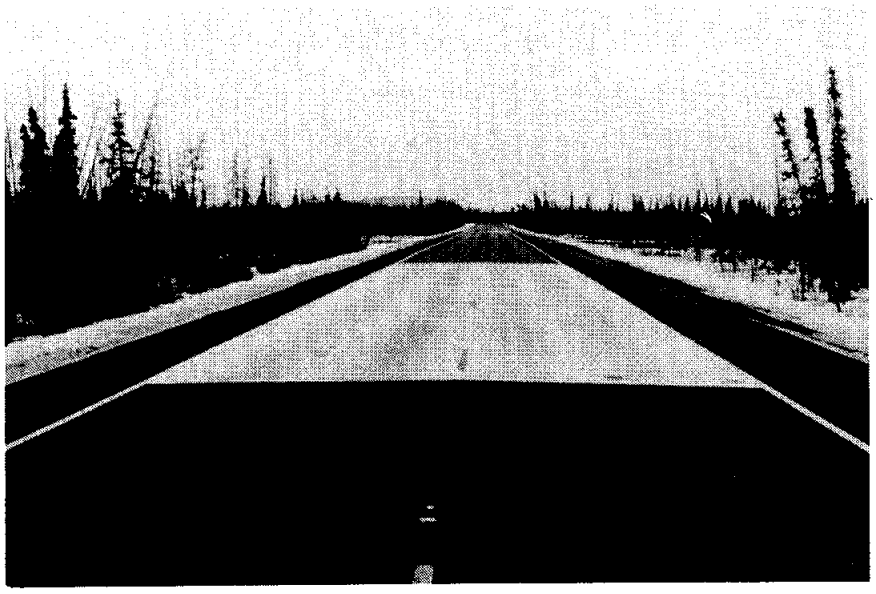


Continuous reaction and batch mode laboratory scale pilot plant for the production of Calcium Magnesium Acetate (CMA).

Permafrost Culvert Study - Culvert installations in permafrost areas present various problems resulting in excessive long-term maintenance costs. Progressive warming of soils beneath the culverts can cause localized thawing which eventually results in the culverts settling below the surrounding ground and requiring their expensive replacement. In other cases, culverts can act as air circulation and cooling ducts, resulting in frost heaves at the culvert sites. The presence of permafrost around culverts also leads to early ice blockage where wintertime water flows must be carried. North Slope culvert studies by the U.S. Army Cold Regions Research and Engineering Laboratory are investigating thaw depth differences between uninsulated and insulated culverts and normal roadway areas.

Engineering Computer Software - This project provided computer terminals and plotting hardware for all three regions of the Department thus enabling the engineering staff to have access to state-of-the-art computer programs. The Washington State Department of Transportation earthwork programs have been transferred onto the Boeing Computer System, which can be accessed by Department terminals. Several training sessions have been conducted to familiarize the engineering staff with these programs. The software has been implemented and transferred to Design and Construction.

Pavement Thermal Study - The purpose of this study is to quantify the effects of pavement color and texture on average surface temperatures of roadway and airfield pavements located on permafrost. This is accomplished through the use of instrumented field test sections located on Peger Road in Fairbanks and at Deadhorse, Alaska. White and yellow painted sections are used in this study along with chip seals of white, regular, and dark rock. A final report will be prepared by October of 1983.



White painted test site near Shaw Creek to measure benefits in reducing thaw-settlements of roadway. (Report No. AK-RD-83-28)

Roadway Strength Inventory - A Falling Weight Deflectometer (FWD) has been purchased to inventory the structural strength of Alaskan highways. The FWD simulates the load imposed on the roadway by a moving truck by dropping a weight onto the surface with a force of 9,000 pounds. The deflection or bending of the roadway is measured and reported in much the same manner as the well-known Benkelman Beam technique.

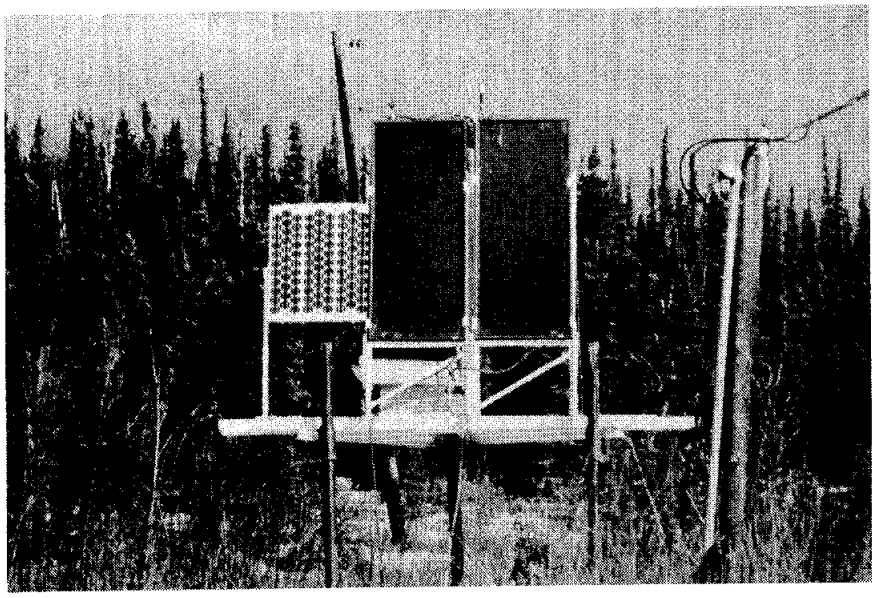
Under this study, deflection data will be collected on an inventory basis. These data will allow estimations of pavement life, overlay thickness requirements, and seasonal load restriction needs. Data is now available for the Parks, Alaska, Richardson, Glenn, and Elliott Highways. The FWD has also been used for both the Anchorage and Fairbanks International Airports.

Frost Heave Test Development - Funds provided under this study are being used to develop new types of frost heave laboratory test cells. They will permit materials engineers to test various soils and pavement layer materials under conditions closely duplicating actual field exposure. These conditions will include the ability to cyclically freeze and thaw the samples, vary the vertical loads and lateral pressures, and duplicate different conditions of water availability and freezing rate. The test program will permit strength testing of the samples during or immediately after thawing.

Low Temperature Thermal Cracking - This study is examining the mechanics and morphology of major transverse thermal cracks that form on Alaskan roads. A field examination of interior Alaskan cracks will be complimented by laboratory investigations into the thermal expansion coefficients of highway construction materials. A primary objective of this research is to form an understanding of the basic physical nature of transverse thermal cracking. Potential solutions to this pavement problem will be evaluated based on project findings.

Thermal Analysis Computer Modeling - Designers are continuously concerned with degredation of permafrost under roadways, airports, and buildings. However, they generally have only rules of thumb and experience on which to base thaw depths. Computer models exist that predict ground temperatures over long periods of time and allow engineers to compare the long-range effects of various design alternatives on the thermal stability of permafrost. The object of this project is to select and verify the most appropriate computerized thermal analysis model for the Department of Transportation and Public Facilities. Report No. AK-RD-82-22, "A Preliminary Evaluation of Numerical Models Suitable for Thermal Analysis of Roadways and Airstrips," discusses computer modeling; other work is still in progress.

Solar-Assisted Culvert Thawing Devices - The objective of this project is to design, assemble, install, and monitor solar-assisted culvert thawing devices that would require minimal operating and maintenance expenses and be built using commercially available components. Two systems currently in the demonstration phase use a solar panel to heat an antifreeze solution circulated through the culvert. Report No. AK-RD-82-10, "Solar-Assisted Culvert Thawing Device," describes model one of this demonstration. A second system utilizing a linear parabolic reflector instead of a flat place collector is presently being studied. Preliminary results indicate that in certain locations these solar assisted culvert thawing devices can result in considerable cost savings by eliminating repeated culvert thawing by maintenance crews. Report No. AK-RD-83-36, "Solar Assisted Culvert Thawing Device, Phase II," describes the results of this second system.



Solar culvert thawing device installed at Grenac Creek on Farmers Loop Road. (Report No. AK-RD-83-36)

Prethawing of Permafrost by Surface Modifications - Repair of roadways having unstable foundations is both a major maintenance item within the Department of Transportation and Public Facilities and a major headache and hazard to the motorist. Experience from old roadways and from roadway test sections reveals that thermally stable embankments can be constructed over thaw unstable soils if a sufficiently thick layer of thawed soil overlies the permafrost. This thawed zone, however, should be developed either before or during the construction phase, not after.

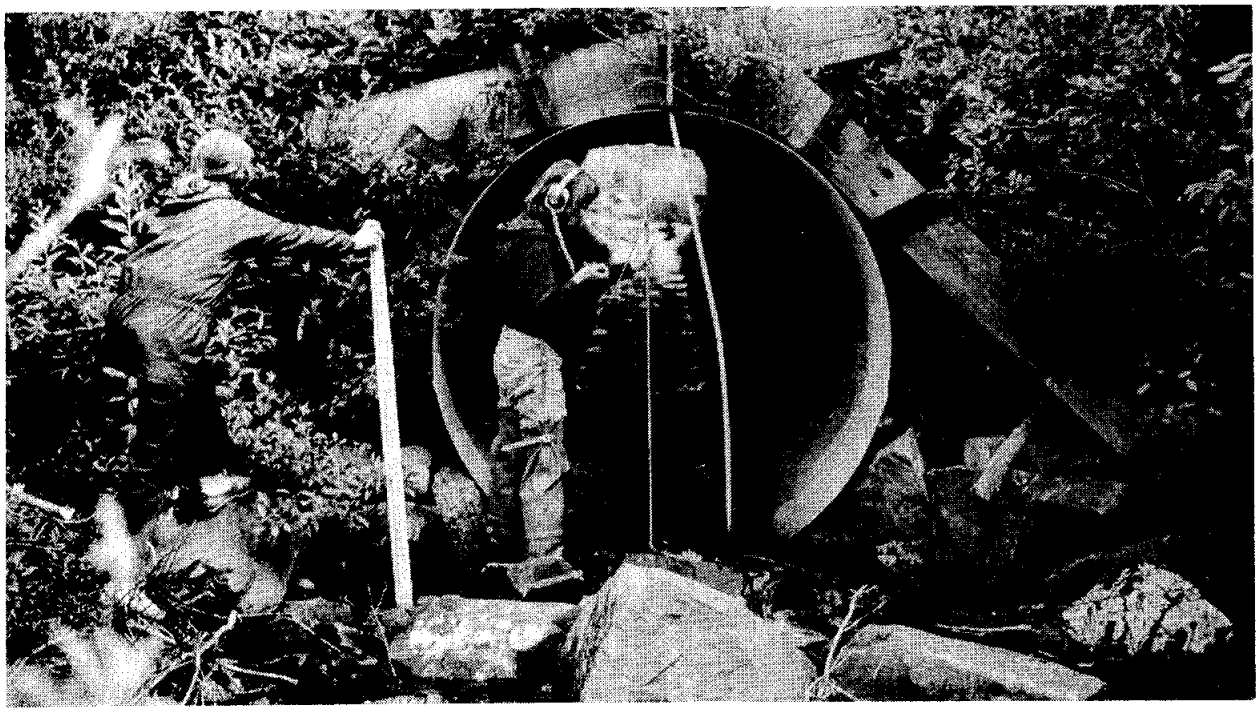
This study investigated (1) the utilization of solar radiation; and (2) the preparation of the ground surface to absorb as much energy as possible as a means of achieving a deeper thaw zone. This process included the removal of the naturally occurring vegetative and organic ground covering and the application of different combinations of gravel, asphalt, and clear polyethylene surface treatments to accelerate the net heat input into the ground during the summer months. The study demonstrated the benefits of surface modifications over a three-year period. A final report was printed and distributed in December, 1982, Report No. AK-RD-83-23, "Permafrost Prethawing by Surface Modifications."

Field Evaluation Site for Ground Ice Detection - Experience with permafrost and ground ice detection programs has demonstrated the need for a permanent evaluation site of known ground truth. A site containing a single subsurface ice mass of known size, shape, and depth was constructed during the winter of 1980-81. A mass of ice approximately 26 inches wide, 10 feet thick, and 120 feet long was constructed and buried 3 1/2 feet deep in an area of nearly homogeneous frozen silt near Fairbanks.

This field site was used to evaluate various geophysical means for detecting subsurface ice from surface measurements. Electrical resistivity measurements, ground penetrating radar surveys, micro-gravity profiles, and other survey techniques were conducted periodically at the site to test dependence on seasonal temperature and moisture variations. A final report, No. FHWA-AK-RD-83-27, "Field Evaluation Site for Ground Ice Detection," was published in March, 1983.

Fish Passage Through Drainage Structures - This major Federal Highway Administration funded project which received approval in late April, 1982, is a three-year study of culvert flow conditions on major highways in the Interior. It includes field investigations of culverts and a review of the literature on the swimming ability of fish, timing of migrations, and other biological factors affecting the ability of various fish species to pass through culverts. It also includes an evaluation of culvert baffles that have been used to aid fish passage.

The project assesses current knowledge about fish passage through drainage structures and gives recommendations for additional field studies that may be needed to answer remaining questions. The costs involved in the current work can be justified if the number of bridges to be built (in place of culverts) is reduced by just one. Seven bridges are currently being built to replace existing culverts on the Dalton Highway during the next two years at a cost of over $7 million. Another four bridges are also being considered on that highway for fish passage reasons. These bridges will cost over $4 million at today's prices.



Institute of Water Resources technicians measure velocity profile of flow in large highway culvert.

Aspects of Streamflow with Regard to Fish Passage - Fish passage through drainage structures has traditionally been viewed in terms of maximum velocities that fish can maintain through given culvert lengths during the mean annual flood. Little work has been done to evaluate fish passage in terms of waiting time needed for a flow peak to subside and the effect of this wait on productivity.

This project brings together available data on streamflow and uses predictive modeling techniques to establish statistical probability of flow peaks and duration thereof. The project includes a literature review regarding biological adaptation to waiting periods during spawning runs. Results include a recommended methodology for establishing fish passage criteria. A draft final report has been received for review by Department Research and Hydrology staffs.

Correlating Dynamic Deflections with Pavement Performance - The purpose of this study is to conduct comparative performance evaluations between the Road Rater and Falling Weight Deflectometer pavement testing devices and select one for routine inventory work on Alaskan pavements. The ability of each instrument to characterize observed pavement condition and to function properly throughout the project's duration will be addressed. A summary report will include selection of a specific equipment type and a methodology for collecting and utilizing field data.

Evaluation of Air Duct Ground Stabilization System - A design manual is being prepared for using air ducts to stabilize thaw-sensitive ground. Coefficients of friction, required stack heights, heat transfer rates, and effects of bends will be determined. All procedures will be compared with the existing air duct installation near Fairbanks.

Geophysical Methods for Detecting Permafrost and Ground Ice - Permafrost can cause substantial problems in the design, construction, and operation of roads, airfields, and buildings. Present foundation investigations in areas of suspected permafrost rely almost entirely on soil borings to determine the nature of the subsurface soils. While drilling does give excellent subsurface information, it can fail to detect a changing soil condition only a short distance from the selected boring site. Other inves-

tigative techniques are needed to provide a lateral view of the soil condition in a specific area to supplement information gained by drilling.

Several geophysical techniques have demonstrated the ability to detect and delineate permafrost and massive ground ice in certain soil types. Electrical resistivity measurements have proved useful in the indentification of subsurface trends and are now being incorporated into state runway, roadway, and material site investigations--particularly remote sites where borehole information is difficult and expensive to obtain. Over ten surveys have been conducted during the past two years at sites under study by state gologists. Efforts are being sought to broaden this program into the detection of general subsurface features and to continue the review of geophysical instruments as they become available. A report on the application of soil resistivity surveys in foundation and material investigations by the Department will be available October, 1983.

Permafrost Research Site Monitoring - Various design features aimed at reducing permafrost-related roadway problems have been incorporated into new roadway construction projects. Following construction, temperature monitoring systems are installed and settlement and movement references established. Continuous air temperature recordings, monthly temperature measurements, and annual thaw and settlement surveys are used to measure long-term benefits of these design features. Studies in this area began in 1969 with construction of an insulated roadway near Chitna and have been progressively expanded to include long-term monitoring at six experimental roadway sites throughout the state. These studies are currently continuing. Progress reports on experimental embankments and insulated cuts were prepared for the 4th International Conference on Permafrost, Report No. AK-RD-84-01, "Experimental Roadways on Permafrost."

Applications of Engineering Fabrics in Alaska - This study is evaluating the successes and failures of all Alaskan engineering fabric installations designed to act as filter layers or roadway fill reinforcement layers. It will provide design guidelines for future projects that will improve their performance. Final report completion is expected in 1983.

Ice Forces on Northern River Bridges - This study provides data on actual ice forces for thick river ice conditions and uses these data to recommend modifications to current code requirements for ice forces on river crossing structures. The site of this work is the Yukon River Bridge on the Dalton Highway where various load cell types have been installed on Pier #5 to measure ice forces during the spring breakup period. This research work is being performed by U.S. Army Cold Regions Research and Engineering Laboratory and the University of Alaska with the assistance of the Department. A final report is planned for 1983.

Mechanistic Design Methods for Alaskan Pavements - This study examined state-of-the-art methods for evaluating the structural designs of asphalt concrete pavements. Selected analytical procedures were made available to the Alaskan pavement engineer through a "user's manual" section in the summary report and installation of selected programs on the University of Alaska and Boeing Computer systems. The project report was issued as FHWA-AK-RD-83-8, "Use of Layered Theory in the Design and Evaluation of Pavement Systems."

Portable Powered Probe for Permafrost - To fulfill the need for a lightweight probe system to determine the depth to permafrost, all available electric impact hammers and hammer drills were reviewed and evaluated for suitability in driving and retrieving steel probe rods. A series of probe rods and rod tips of different designs were fabricated for testing. The system determined most favorable is based on a 1/2 inch electric impact drill driving 1/2 inch segmented rods with an enlarged 5/8 inch bullet nose tip. The rotation of the rods is important for ease of penetration and retrieval of the rods. The final report published in August, 1982, is Report No. AK-RD-83-12, "Portable Powered Probe for Permafrost."

Rubberized Asphalt for Roadway Ice Control - This project evaluated test sections and paving mixes of asphalt pavements constructed with 3% to 4% of roughly 1/8 inch-sized ground rubber particles included in the paving mixes. The purpose of this study was to determine the benefits of rubber particles in reducing surface ice formation and increasing tire friction in

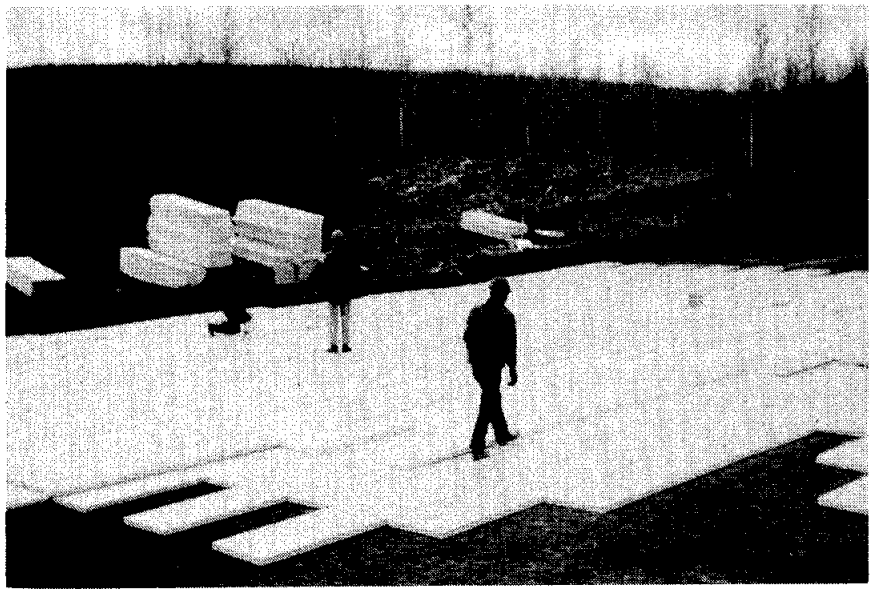
winter. Test sections totaling approximately 2.5 miles have been constructed in both Fairbanks and Anchorage and evaluated for durability and skid reduction. Fairbanks data, the most comprehensive, indicate an average 25% reduction in icy road stopping distances as a result of this test material. A final report will be published in August of 1983.

Soil Stabilization for Remote Area Roads - Literature reviews were made to assist in determining the most suitable soil stabilization methods. Soil surveys were performed in gravel-deficient areas of Alaska scheduled for future transportation projects to determine typical soil properties. Samples for laboratory evaluations of the benefits of different stabilization treatments were obtained. The benefits of various emulsified asphalts and cement were then measured by extensive laboratory testing. The outcome of this study indicates that favorable results can be attained with some sandy soils while others are more resistant to beneficial treatments. A final report is in the review stage and will be completed by summer of 1983.

Evaluation of Road Rater Test Methods - The purpose of this study is to provide an operational evaluation of the Road Rater Model 400A pavement deflection test device 400A by defining: 1) the load/frequency operating mode that provides the best correlations to Benkelman Beam deflections; 2) pavement temperature effects on Road Rater deflections; and 3) proper sampling frequencies. Objectives of this project include the development of a standardized test method for use of the Road Rater in Alaskan pavement design. Results indicated the Road Rater was not acceptably accurate or reliable for pavement testing during the critical spring thawing season. A final report is in preparation.

Economic Aspects of High Speed Unpaved Roads - The costs of constructing and maintaining gravel roads with dust control procedures as utilized in the Yukon Territory were compared with the costs of constructing and maintaining paved roads in permafrost areas between Fairbanks and the U.S./Canada border. A conclusion reached in the final report, AK-RD-83-20, "Economic Aspects of High Speed Gravel Roads," was that gravel roads with dust control are an option which should be considered for use in severe permafrost conditions.

Design Guide for Pavements over Permafrost - A design guide was prepared to include aspects of permafrost engineering related to roadways and to bridge the gap between the latest research work and previously used procedures. This primarily provided background information to assist the designer of roadways constructed over permafrost. The final report published is AK-RD-83-15, "Design Considerations for Roadways on Permafrost."



Experimental roadway insulation over permafrost at Alder Creek test site. (Report No. AK-RD-84-01)

Design Manual for Roadways over Muskeg - This project involved compiling available literature and data analysis methods to serve as a guide roadway design over muskeg terrain. The latest soil reinforcement for methods with soil-fabric aggregate systems were analyzed in light of all other available methods and their applications evaluated. A manual was published as Report No. AK-RD-83-14, "Design Methods for Muskeg Area Roads."

Stress Monitoring of New Gastineau Channel Bridge - A new and innovative design for a prestressed segmental concrete bridge structure was constructed across the Gastineau Channel at Juneau during 1980 and 1981. The strain and deflection history of the cantilever and anchor spans are being measured and compared with the load history and theoretical predictions of these same strains and deflection. Particular emphasis is placed on the monitoring of creep. Studies have been extended into 1984 to include one year of in-service data. The purpose of this research is to monitor the structural behavior of the new bridge so that it can serve as a full-scale model to provide information for advancing the state-of-the-art of designing and constructing segmental structures.

Remote Monitoring of Springtime Thaw Depths - During the spring, most of the state roads experience thaw that results in a saturated base or subbase layer which is unable to provide structural support. Spring load restrictions are therefore imposed to protect the highway surface integrity until the embankment can regain its structural strength. It has been demonstrated that thaw depth can be directly correlated with the roadway deflection, and it is evident that accurate and inexpensive methods of determining the load-bearing status of a given roadway are needed. In this study, methods of remotely monitoring the depth of the freeze/thaw boundary in a reliable manner are being sought. Several devices were installed in the Fairbanks area in April, 1982 and are currently being evaluated. Radio telemetry of data from these devices was attempted in the spring of 1983 with limited success.

4th International Conference on Permafrost - Federal funding was provided to the Geophysical Institute of the University of Alaska for use in organizing and hosting the 4th International Conference on Permafrost held in Fairbanks in July, 1983. The conference was attended by over 900 participants from 25 countries and resulted in exchanges of information on the diverse problems presented by permafrost. Department of Transportation and Public Facilities Commissioner Daniel Casey gave the welcoming address at the Conference on behalf of Governor Sheffield.

Commissioner Dan Casey welcoming participants to the Fourth International Conference on Permafrost.

Bridge Construction on Permafrost - In 1965, three bridges were constructed and founded on permafrost near Fairbanks. Instrumentation was installed to permit long-term temperature monitoring and elevation surveys to be made for several years to measure long-term movements. The purpose of this project is to obtain new temperature and movement data after 17 years of service. The final report now being reviewed analyzes the long-term performance of these structures and provides recommendations for use on new designs for similar conditions.

Use of Preheated Maintenance Sand for Skid Control - Maintenance crews have found that the application of cold sand or rock chips is inadequate for icy road skid control because the sand and chips are blown or pushed off the roadway surface shortly after placement. If these materials could be bonded to the surface, they would provide increased traction and safety. It may be possible to achieve greater bonding by heating the sand so that it will melt into the ice and refreeze, providing a sandpaper-like surface.

The objective of this study is to explore the benefits of preheating maintenance sand. The study will include both an analysis of the sand application method and an economic analysis. Several methods of heating were investigated to determine the best method. Coldroom test track studies are being conducted in the coldroom facilities of Penn State University. A final report is scheduled for the fall of 1983.

Highway Thaw/Settlement Control - There are a number of highway routes within the interior of Alaska that suffer continually from thaw and settlement problems. These areas require considerable maintenance effort annually and at times can become a safety hazard to the traveling public due to the rapid differential settlements that occur during the thawing season.

The objective of this study is to determine the feasibility and effectiveness of reducing thaw and settlement by reflection of solar energy from the roadway surface. This will be accomplished through periodic applications of white paint to the roadway in selected locations followed by accurate settlement surveys on a series of painted and unpainted problem areas. Three roadway test sites located at Johnson Road, Canyon Creek, and Shaw Creek between Fairbanks and Delta Junction are currently being evaluated.

Evaluation of AC-1.75 Asphalt - Thermal cracking damage is occurring on most Alaskan pavements. In order to minimize this problem, design practice usually calls for use of very soft asphalt materials. At the present time, AC-2.5 is the softest grade of asphalt cement available for use on the state's highways. Although present materials provide generally good construction and performance characteristics, none have successfully pre-

vented thermal cracking. In an attempt to alleviate this problem, experimental road sections utilizing a specially produced AC-1.75 asphalt and also Chem-Crete, an asphalt modifier, were constructed on the Richardson Highway about 80 miles southeast of Fairbanks near Shaw Creek. This research will evaluate overall performance by comparing these products with the project's non-experimental AC-2.5 sections. The results of this research will determine the feasibility of AC-1.75 and Chem-Crete use in Alaska.

Decision Criteria for Seal Coating - The purpose of this study is to develop a decision policy to determine when a seal coat should be applied for purposes of extending the life of an asphalt pavement. Inventory methods will be developed and tested to provide information necessary to allow acceptable budgetary lead time.

The selection of the seal type depends upon the defect being corrected, availability of materials and equipment, and local climatic conditions. The selection process will require a field assessment of these defects, and a specialized roadway inventory method must be developed that can eventually be merged with current inventory.

Pile Frost Jacking Study - During winter, bridge and building foundation pilings are often subjected to very high uplifting or jacking forces as the surface of the ground freezes and heaves upward from frost action and ice segregation. Piling must be designed to resist this uplifting as the soil layers surrounding the pile grip the pile and slide upward during much of the winter. This study is being made on two test piles instrumented with strain and temperature indicators at six inch intervals of depth. A computer is used to measure pile jacking forces hourly, as they vary with depth and temperature. The jacking forces resulting from silt, gravel, and ice layers surrounding the test piles are being evaluated to develop better design criteria for pile design.

Instrumented frost heave test pile prior to installation in pre-drilled hole.

ENERGY AND BUILDINGS RESEARCH PROGRAM

Passive Solar Alaskan School - The Passive Solar Alaskan School Project, jointly funded by the State of Alaska and the U.S. Department of Energy, seeks to develop cost-effective design criteria for integrating solar energy collection features into Alaskan public buildings. Phase I of this project concentrated on the development of a unit school building which would receive 45% of the space heating requirement and a similar portion of its lighting energy by collection of solar energy. Refer to Report No. AK-RD-81-10, "Passive Solar Alaskan School." In Phases II and III, which are nearly completed, the unit building concept is thematically repeated in a larger and more complex building, the Two Rivers School. Located approximately 20 miles northeast of Fairbanks, this school was completed by the fall of 1982. In addition to south-facing windows and vertical overhang shading, one room of the school is equipped with a thermal shutter system which is automatically controllable by internal lighting levels and temperatures. Verification of design calculations as well as an economic evaluation of cost effectiveness is being made following one full year of energy usage monitoring. "Two Rivers Passive Solar Design Analysis," Report No. AK-RD-82-18, an analysis of the school's passive solar design, is currently available.

Moist Insulation Study - When subjected to large indoor vs. outdoor temperature extremes, building wall sections have a propensity to condense water vapor which has penetrated the interior surface and to accumulate moisture in the insulation. This study is investigating the extent of this problem with in situ moisture measurements from existing buildings and will determine the degree to which thermal resistance of the moist insulation is reduced. The latter measurements are being performed in the Research Section's Guarded Hot Box Facility.

DOTPF Communications - Reliable communications between administrative centers and field maintenance crews are essential to the mission of the Department. Public safety and the safety and efficiency of operating personnel are critically dependent on good communications. A system should provide coverage of the Alaskan roads and include provisions for digital data transmissions as well as voice communications.

All complex communication systems should be periodically evaluated by an impartial review process external to the normal maintenance and operation authority. In this way improvements and innovative advances consistent with the ever-changing state-of-the-art in communications may be recommended for possible incorporation into the system. This study will accomplish these important tasks using qualified and experienced Alaskan communication engineers and technicians based at the School of Engineering, University of Alaska.

This project is a complete review of the existing highway communications system serving the Department including voice, data, and facsimile communications. It encompasses field inspection of all existing base station equipment including antenna integrity and impedance matching, transmission line quality and state of repair, overall transceiver efficiency, and signal strength surveys for specified areas of marginal communications. Interviews with Division foremen and radio operators will be conducted to determine performance and circuit reliability as seen from the user's perspective.

A system evaluation based on field data will be prepared and cross-checked with users. The evaluation will be analyzed to determine deficiencies in reliability and coverage for all locations. The system analysis will be used to generate specifications for improvement of service and coverage.

Building Failures Survey - The State of Alaska has been constructing buildings at an unprecedented rate for the last decade. Primarily due to the structure of the Department of Public Works and later Department of Transportation and Public Facilities, very little feedback from building maintenance personnel has ever been incorporated in the design process of new structures. This system inherently repeats design mistakes and continues to inflate maintenance costs. Research, being performed by Stan-

dards and Technical Services personnel, is currently searching project records for building maintenance problems and cataloging them on the state computer system. When completed, this information will be used by Standards and Technical Services as they continue to establish design standards and by general design and construction and their architectural contractors in the design of new buildings.

Thermal Performance Standards for State Buildings - The Department has adopted the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Thermal Performance Standard (Energy Conservation in New Building Design) as the minimum energy efficiency level which the state will accept in new building construction. Recognizing however, that the ASHRAE standard was developed for a temperate climate, the Alaska statutes require the development of a modified standard more suited to high latitudes.

During the past year a draft thermal and lighting performance standard has been completed and hopefully will be implemented soon. The standard is so far limited to the class of buildings typified by the small rural school. In the continuing phases of this project, this limited standard will be added to and modified until as many as possible building types and classes, typically built and operated by the state, can be included. The reports now published as part of this project are:

"Phase I, A Thermal Performance Design Optimization for Small Rural Schools," AK-RD-81-19.

"Phase II, A Thermal Performance Design Optimization for Small Alaskan Rural Schools," AK-RD-83-2.

"Thermal Cost Analysis of Thermal Envelopes for a Small Rural School," AK-RD-83-3.

Buildings Energy Conservation Studies - Under this heading are several individual projects aimed at reducing state expenditures for energy required in new and existing buildings. The thrust of this work is intended to contribute to the overall reduction of maintenance and operation costs of state buildings which are rapidly increasing.

The following six entries are part of a comprehensive project.

1) Thermal Load Simulation for Small Buildings (F-LOAD) - F-LOAD is an interactive computer program that calculates the heating load of residential and light commercial/institutional buildings. This program allows the incorporation of passive solar systems for heating as well as conventional heating systems. An optional economics section computes the life cycle cost of heating for the structure. The program serves as a quick and useful reference tool for comparison of heating loads for various design options, such as:

- varied insulation thicknesses in walls, ceilings, and floors;
- varied air change rates;
- building orientation;
- fuel type; and
- various passive solar energy features.

The F-LOAD program has been made available to personnel working for the Department. Workshops have been conducted in Anchorage, Fairbanks, and Juneau for Buildings and Harbors and Planning and Programming personnel to introduce them to the various uses of the program and give them hands-on experience in its operation. During the past year Research Section staff have assisted several project managers when using F-LOAD for a specific building project.

The program is presently on the University's Honeywell computer. An effort will be made this next year to place the program on the state's computer system for easier access by state employees.

2) Insulation Shape Factors - When calculating the heat loss from a building envelope, it is usually assumed that a steady-state, one-dimensional heat transfer analysis is applicable. However, with the presently recommended construction methods, wall thicknesses have increased and below-grade insulation techniques have developed to the point where that assumption may no longer be appropriate. A two-dimensional heat transfer analysis is being performed to develop shape factors for fenestration components and below-grade insulation techniques of a "super insulated" structure. This will be presented in graphical form from which a shape factor for a specific design can be determined and the heat loss calculated.

3) Public Facilities Design Standards Review - The Department's Standards and Technical Services is currently developing materials, design, and construction standards and specifications to be used by architectural and engineering firms for designing public facilities. This project provides for a Research Section review of those standards and specifications prior to publication so that the results of presently completed research can be implemented into the routine operations of the Department. This review also aids the Research Section in identifying those areas regarding specifications and standards where further research is needed.

4) Furnace Efficiency - There are many devices on the market today that claim to increase the efficiency of an existing oil-fired furnace/boiler. Very little independent testing has been done on such devices. Consequently, the manufacturers' claims are all that is available to the consumer. By request of the Department's Northern Region Building Maintenance Section, this project will examine the effectiveness of a combustion air ionizer. The project will also perform rigorous efficiency testing of an unaltered furnace/boiler to provide the Department with good baseline furnace efficiency data.

Researcher Joe Durrenburger runs bag sample of flue gases through combustion analyzer to determine furnace efficiency.

Two additional projects are underway that will help determine how much energy can be saved by using the latest commercially available combustion technology on oil and gas burning furnaces and boilers throughout Alaska. One project surveys the literature and gathers information on the level of technology and maintenance currently available and in use here and elsewhere. The other is a field survey of current combustion efficiency in selected buildings using both "furnace repairman type" and more sophisticated testing equipment.

5) Architectural Materials Testing - This project provides for the maintenance and operation of the Research Section's Guarded Hot Box Facility. This device is used to measure the thermal resistance and moisture permeability of building materials, wall sections, windows and shutter systems, etc.

6) Metal Stud Walls - Based on a study performed under contract to the Department by consultant J.S. Strandberg Consulting Engineers, (Report No. AK-RD-83-3, "Thermal Cost Analysis of Thermal Envelopes for a Small Rural School"), the most economical wall section for small institutional type buildings in most areas of Alaska is a composite of a 2 x 6 stud wall with fiberglass batt insulation and 1 1/2 inch rigid foam insulation sheathing. Furthermore, for ease of construction, wood framing is often replaced with metal studs. While methods exist for calculating the thermal performance of a metal stud wall, American Society of Heating, Refrigerating, and Air-Conditioning Engineers recommends that testing be done to accurately make this determination. Metal stud wall sections with and without exterior foam sheathing are being tested for thermal performance in the Research Section's Guarded Hot Box.

Remote Facilities Monitoring - The State of Alaska operates a variety of remote facilities that are not regularly attended by skilled technicians. Many utility failures within these facilities could be detected by monitoring systems and preventive action taken before catastrophic failures occur. Savings in fuel for heating and electric energy might also result from prompt identification of inefficient operating conditions or faulty equipment.

Report No. AK-RD-82-11, "Maintenance Monitoring for Remote Public Facilities--A Feasibility Study," identifies dominant maintenance problems in remote facilities, means by which they can be detected, the level of monitoring appropriate to various facilities, and a strategy for implementation. Recommendations for the implementation of monitoring systems are described in the following paragraphs:

1) Rural Electric Power Quality - Many operational problems associated with electrical equipment installed in rural facilities originate from voltage and frequency excursions in the power grid to which the facility is connected, or in the on-site power plant in the case of a self-generating facility. These disturbances range from actual power outages to voltage sags and surges, voltage impulses, and frequency deviations. The objectives of this project are to determine the extent to which electric power disturbances affect the physical plants of rural state-owned and operated facilities and to recommend techniques and hardware to protect the facilities from poor power quality. During the winter and spring of 1982-83, power quality data was gathered from three rural state facilities. This data is currently being analyzed. A report is expected by December, 1983.

2) Freeze-Up Alarms - Research Section personnel along with J.S. Strandberg Consulting Engineers have designed a freeze-up alarm system for use in alerting maintenance personnel to abnormally low temperatures within state facilities. Three units have been constructed and will be installed in existing structures where there has been a history of freeze-ups and in facilities where freeze-ups would result in a substantial loss of both use and repair of that facility.

A freeze-up alarm demonstration session was conducted by the Research Section for interested Department personnel this past December. As a result of the session, one of the freeze alarms has been installed in an unattended warm storage building at the Barrow Airport which houses an airport fire truck and safety equipment. Some site specific problems have occurred with the installed system, but changes have been made to resolve these and keep the freeze-up alarm operable.

3) Monitoring of Heat Generation Equipment - It may be possible to more accurately control the fuel usage of rural facilities by monitoring various parameters of the heat generation and delivery systems. During FY83 some preliminary work was done toward the development of a monitoring system in support of the thermal performance standards project. It is anticipated that this system will be implemented and tested during FY83.

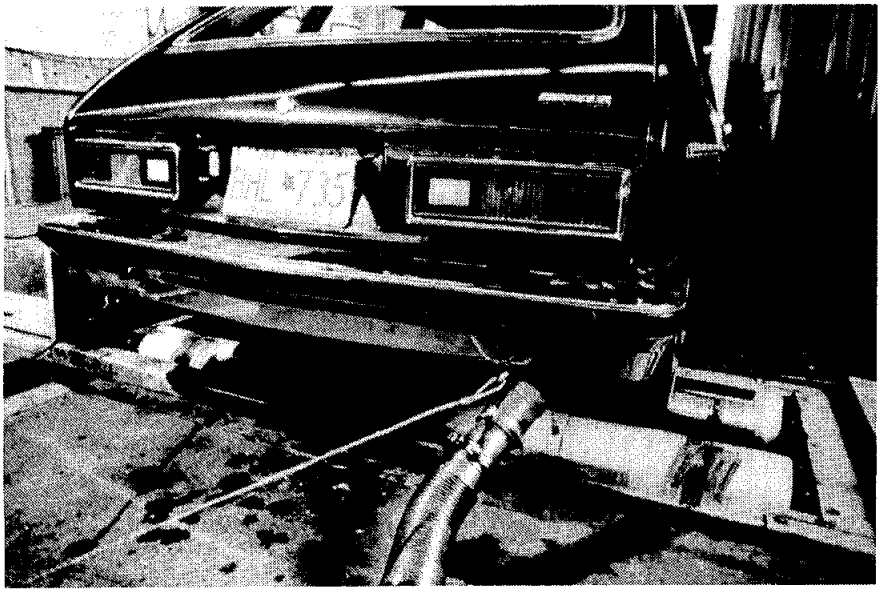
Fuel Cell Evaluation - Because of the high energy-conversion efficiency of fuel cells, they offer a potentially attractive alternative to the deisel-electric generators presently used in rural Alaska. The objective of this project has been to evaluate the feasibility of using a methanol-fueled phosphoric acid fuel cell (PAFC) as an electric power source to replace the diesel-electric generators now used in many rural Alaskan state buildings.

The evaluation has addressed the safety, operation, reliability, maintenance, and cost aspects of the fuel cell power plant that are generic to the Alaskan environment and to preliminarily assess feasibility. The study, which is now complete, has concluded that the extra transportation cost required by the lower energy density of methonol would more than offset any cost savings which a fuel cell might enjoy over a diesel-electric system based on improved efficiency of the part-load performance of fuel cells. It was also concluded that the present state of the commercial fuel cell industry is not yet adequate to support viable demonstration models for rural Alaskan applications. The final report for this project, AK-RD-84-02, "Fuel Cell Power Plants in Rural Alaska," is now in draft and will be available by September, 1983.

Roofing Design and Materials Investigation - Maintaining the integrity of roofs is a major portion of the upkeep cost for state facilities. Recent findings of the Building Failures Survey project indicate that approximately one-third of building failures are roof related. Investigation by the Research Section has shown that new knowledge is not required to construct a quality roof. However, if improperly handled, any combination of design, materials, and/or construction procedures can contribute to roof system failures. The objective of this project is to develop standards and specifications for roofing designs, materials, and construction techniques addressing varying climatic zones and geographic areas. In addition, a main-

tenance checklist and inspection schedule for each generic roofing system will be recommended. This information will be presented in a set of building design standards being developed and assembled by Department of Transportation and Public Facilities Standards and Technical Services for use by Public Facilities architectural and engineering consultants.

Vehicle Emission - Effects on Air Quality - This project investigated the effects of inspection and maintenance (I/M) on carbon monoxide emissions from Alaskan vehicles. The results have been used to prepare strategies for reducing emissions in Fairbanks and Anchorage as required by the Clean Air Act. The research indicated that an I/M program alone, if conducted properly, will reduce emissions enough to satisfy the U.S. Environmental Protection Agency. A research report entitled "Low Temperature Automotive Emissions/Inspection and Maintenance Effectiveness" is being compiled.



Vehicle exhaust testing while running on a dynamometer during cold weather emissions testing program.

Public Facilities Building Codes - Since the oil embargo of 1973, there has been an ever-increasing nationwide emphasis on revision of building codes. Unfortunately, existing codes are not entirely suitable for the climatic extremes of Alaska. This project involves a review of relevant codes to identify and prioritize areas where new solutions are needed for state facilities. A draft report, AK-RD-84-03, "Public Facility Building Codes," has been submitted, reviewed, and returned to the consultant for finalizing.

Public Building Life Cycle Costing - As the cost of operating and maintaining buildings increases due to escalating energy and labor costs, the mathematical parameters used in arriving at the total life cycle cost become more critical. This project is evaluating the trade-offs between initial costs and continuing costs of state buildings. The goal of this project is to develop a set of economic parameters that best represent the least cost to the state when using lowest life cycle cost calculation methods.

Utility Freeze Protection - Power outages and equipment failures are common in rural areas where replacement parts and the technical knowledge necessary for repair of downed equipment are not always readily available. The time between the disruption of the utility service and a successful repair can result in further system damage from broken pipes due to freezing.

The utility freeze protection project has been developed to test the usefulness of phase-change salts in prolonging the time it takes a utilidor to drop to freezing temperatures after a power outage has occurred. This "time extension" could allow a qualified maintenance person time to arrive with parts to fix the problem before additional system damage results.

Testing has been completed on a utilidor section in the university's coldroom facility. Water and sewer pipes were placed in the utilidor and tests were run both with and without the salts at coldroom temperatures of +10°F, 0°F, and -10°F.

Building Air Quality - An investigation of the ventilation system at the State Courthouse in Fairbanks was completed in April, 1983. Research Report No. AK-RD-83-32, "Ventilation Study of State Courthouse at Fairbanks, Alaska," gives results of the study and makes recommendations for courtroom air conditioning and ventilating improvements. Problems with the indoor environment at the Courthouse have been a source of recurring complaints from judges, jury members, and state employees located there. This investigation is a first step toward a practical way of resolving a very difficult and trying situation for those affected by the adverse temperature and air quality conditions at the Courthouse.

Other work in building air quality included a winter-long study of seven buildings in the Fairbanks area to determine their air exchange characteristics. The sulfur hexafluoride gas tracer method was used for short term, weekly measurements. In addition, a continuous perfluorocarbon passive sampling method developed by Brookhaven National Laboratories was evaluated during March and April. This work is being done to establish baseline air exchange characteristics for a variety of building types and to improve our capability for air exchange rate monitoring.

Noorvik Airport Lighting Demonstration - During the summer and fall of 1979, a feasibility study was conducted to identify and develop a highly reliable, low maintenance electric power supply system to serve as an appropriate alternative to the diesel-electric generator for powering runway lighting systems at rural Alaskan airports lacking available power. That project recommended an organic Rankine cycle turbo-electric generator and a large battery bank as primary components. The major advantages of this system are its high reliability, minimal maintenance requirements, and relatively long life cycle (20 years). It was found that this generator also permitted the use of a simple waste heat recovery system to greatly enhance overall efficiency, plus a photovoltaic solar panel to maintain fully charged batteries during the summer months.

In early October, 1980, an FAA-approved lighting system was installed at the Noorvik airport using village supplied electricity as the power source. In late March, 1981 two Ormat organic Rankine cycle generators were installed. This project provided a demonstration for comparison of reliability and costs of both power sources. The system operated nearly unattended, demonstrating its effectiveness. This work was performed by Ormat Systems, Inc. Report No. AK-RD-83-18, "The Demonstration at Noorvik of an Unattended, Pilot Operated Airport Lighting System" describes the project.

Paint Performance Testing - The Division of Maintenance and Operations presently utilizes traffic paint specifications that detail the composition of paint which will qualify under Department bid specifications. It has been found, however, that these specifications do not always determine the durability of the paint. The purpose of this testing is to develop a bid procedure where the major criteria is the durability of the paint in order to reduce the cost of traffic painting. This work was performed by Woodward-Clyde Consultants and Report No. AK-RD-83-18, "Paint Performance Testing" details their findings.

Transportation Research Projects - This program includes four research projects as follows:

"Design Criteria for Driven Piles" is a review of existing driven pile technology by consultant Peratrovich and Nottingham, Inc. A design guide was developed which can be applied directly to arctic or permafrost foundation installations. The results are described in Report No. AK-RD-83-19, "Design Criteria for Driven Piles in Permafrost."

"Corrosion Research and Recommendations" is an analysis of existing corrosion information and data in order to develop specific recommendations for future design applications and for winter road maintenance procedures. This project was performed by consultant Peratrovich, Nottingham, and Drage, Inc. who produced Report No. AK-RD-83-26, "Corrosion in the Alaska Marine Environment."

"Fairbanks Traffic System Research" is a development project being conducted by the Northern Region Design and Construction Traffic Section and involves changes to components of portions of the Fairbanks transportation system including purchase of traffic control hardware.

"Alaska Road Commission Historical Narrative" completes Phase III (1925 to 1956) and combines that phase with two previous phases (1905 to 1924) into an integrated narrative. The work has been accomplished by the Geophysical Institute, University of Alaska, Fairbanks. The published report is AK-RD-83-37, "Alaska Road Commission Historical Narrative."

Alternative Transportation Modals - This demonstration utilized a 160-passenger Boeing Jetfoil to study the capability of hydrofoil operation in Southeast Alaska. The project ran for two periods: summer from mid-August to mid-September, 1982 and winter from mid-January to mid-February, 1983. Approximately 225 hours of ship time were provided. Costs of operations and feasibility of the craft were assessed during the demonstration which was performed by The Boeing Company. A report on the project is currently being written.

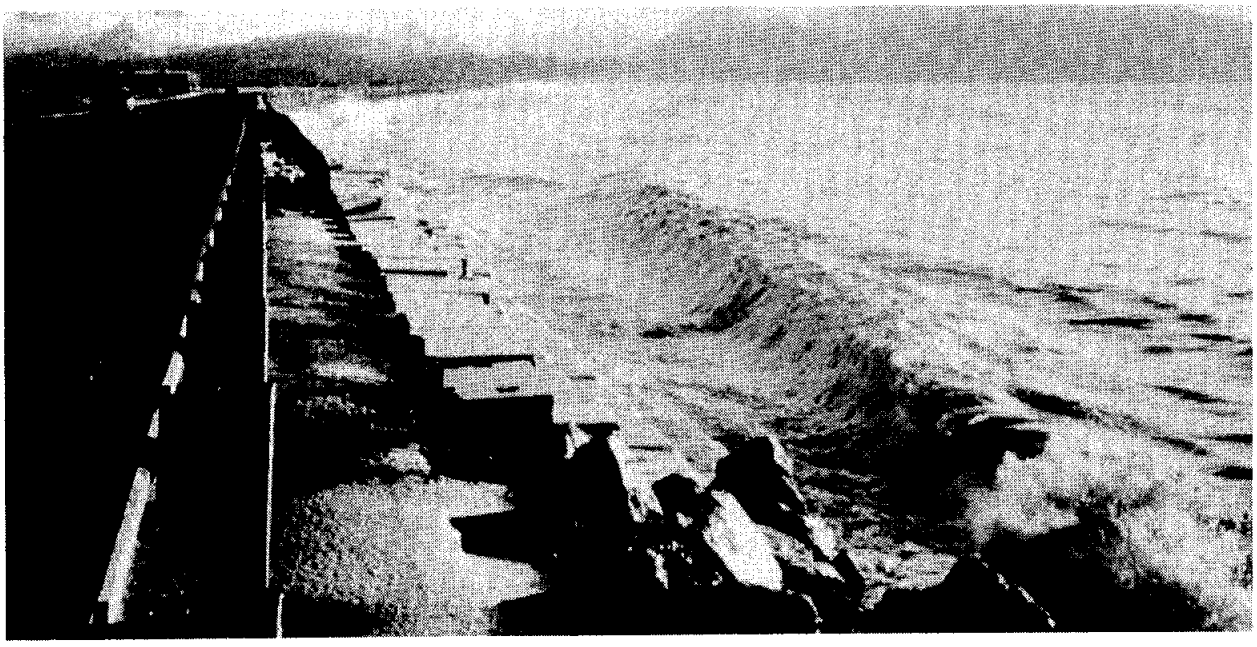
Icebreaker Trafficability Studies, Phase V - This is a continuing contract with the U.S. Maritime Administration. The objectives of the project are to define environmental conditions that affect navigation along potential trade routes in the Bering and Chukchi Seas, to evaluate ship performance in that environment, and to assess operational performance requirements for future commercial icebreaking ships operating along those trade routes.

Aircraft Hydroplaning Prevention - Aircraft accidents attributed to the hydroplaning phenomena are of major national concern, and the Federal Aviation Administration has embarked on a program to have at least one runway at each air carrier airport served by jet transports to be either grooved or have a porous friction course (PFC) surface. To date there has not been adequate study of these preventive measures against hydroplaning in an arctic environment. This project will study these techniques and document the need for hydroplaning prevention measures, as well as estimate the effects in terms of additional user costs of runway design, construction, and maintenance alternatives. Two different hydroplaning prevention techniques are presently being incorporated into the Kodiak airport runway. A report describing this work will be published in the fall of 1983.

Automated Weather Reporting Demonstration - An Automated Weather Observing System (AWOS) which will automatically acquire, process, and disseminate aviation weather observations is currently being studied. The system information will include wind speed and direction, temperature, dew point, precipitation occurrence and quantity, altimeter setting, visibility, cloud height and ceiling, density, altitude, time, and airport identification. The AWOS equipment will be located at Valdez, Farewell, and Galena where manned weather observations will be compared with AWOS data to verify accuracy and pilot acceptance of the automated system. The Galena AWOS site work will be accomplished by the Federal Aviation Administration (FAA) under contract to the Department.

Asphalt Aggregate Specifications, Phase I - A laboratory study is being performed to look at the resilient modulus and fatigue properties of pavement structure materials. Strength differences will be determined for variations in aggregate gradation and fracture. This project will attempt to determine specifications which can be applied equally to both highway and airport materials without compromising the strength of the design. The work is being accomplished by the Transportation Research Institute of Oregon State University.

Breakwater Monitoring - A damaged portion of the Homer Spit was repaired during the fall of 1982 using a new type of concrete shore protection technique. This project monitored the new protection and spit action to determine the ability of this new design concept to prevent littoral drift, including areas of deposition and scour. Also, a more detailed study was begun to acquire data for a long-term solution to the erosion problems of the Spit. The work to date has been accomplished by Peratrovich, Nottingham and Drage, Inc. and an interim report AK-RD-83-24, "Littoral Drift and Spit Degradation on Homer Spit, Alaska," was recently published.



A concrete block erosion control system being tested on the Homer Spit. (Report No. AK-RD-83-24)

Bridge Deck Repair Techniques - This project will involve monitoring the performance of four bridge deck repairs in the Fairbanks area scheduled to be completed during the 1982 and 1983 construction seasons. One bridge deck is being repaired in part by using a cathodic protection system while the three other decks will simply be overlaid using latex-modified concrete. The purpose of this study is to compare actual field data taken during the monitoring program with design assumptions and evaluate the successfulness and cost efficiency of both deck repair techniques. Report No. AK-RD-83-35, "Bridge Deck Repair Techniques," describes the results of this study.

Corrosion Research, Phase II - This study will analyze data collected during Phase I from existing installations throughout Alaska and from research literature on corrosion rates of vehicles, bridges, decks, and other structures. Winter road maintenance methods will be researched and analyzed for cost and suitability. Information obtained under this study will be used to develop specific recommendations for future design applications and winter road maintenance procedures. The work is being performed by Peratrovich, Nottingham, and Drage, Inc.

Earthquake Hazards - This project analyzed data on Alaskan earthquakes to compute expected recurrence intervals for various magnitudes of earthquakes that have occurred along the main transportation corridors. The final report produced from this research will be used by designers when evaluating the earthquake hazards in conjunction with design work. Report No. AK-RD-83-30, "Earthquake Hazards in the Alaska Transportation Corridors," produced by the Geophysical Institute of the University of Alaska, Fairbanks, is being completed.

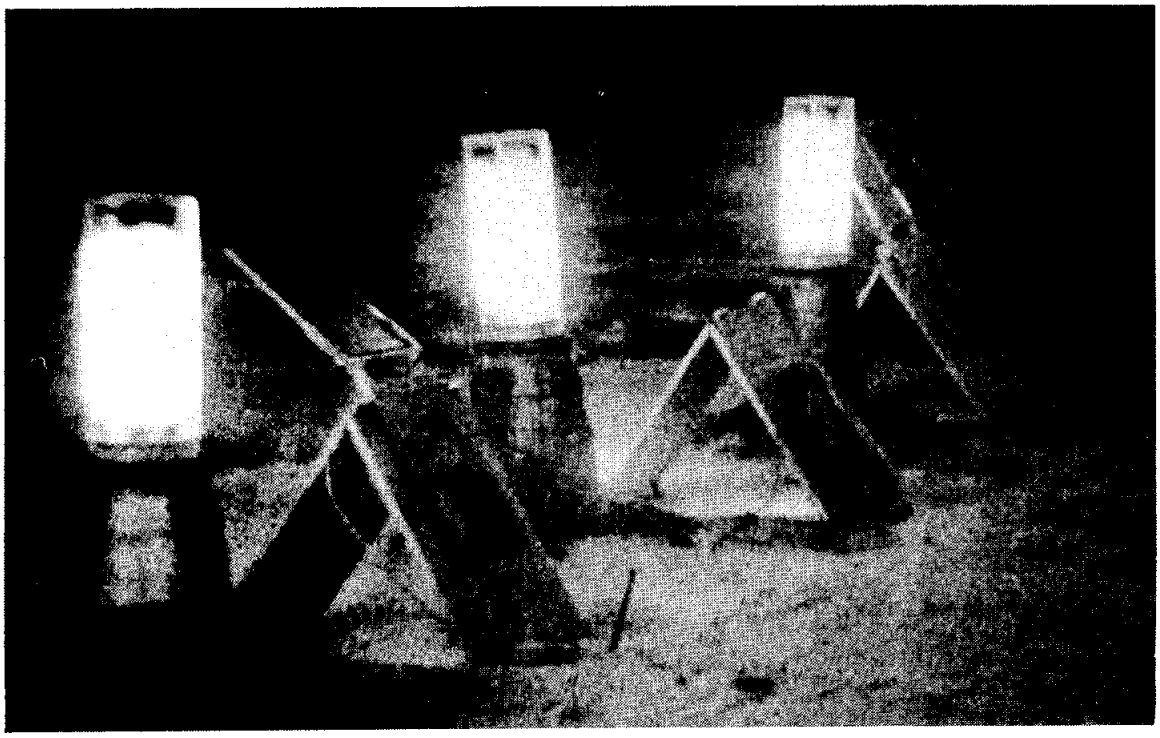
Effective Corrosion Protection - A study will be made which assesses the advantages and/or disadvantages of hot-dipped galvanized piling versus epoxy-treated piling with a sacrificial anode cathodic protection system. Generally, hot-dipped galvanized piling is being used in the salt water environment of marine facilities. This galvanizing protection, while

effective, may have a limited maintenance-free life varying from 10 to 15 years before measures such as cathodic protection must be applied. This is a costly and sometimes ineffective maintenance effort. The assessment will consist of a demonstration project as a portion of a new facility being constructed in a marine environment.

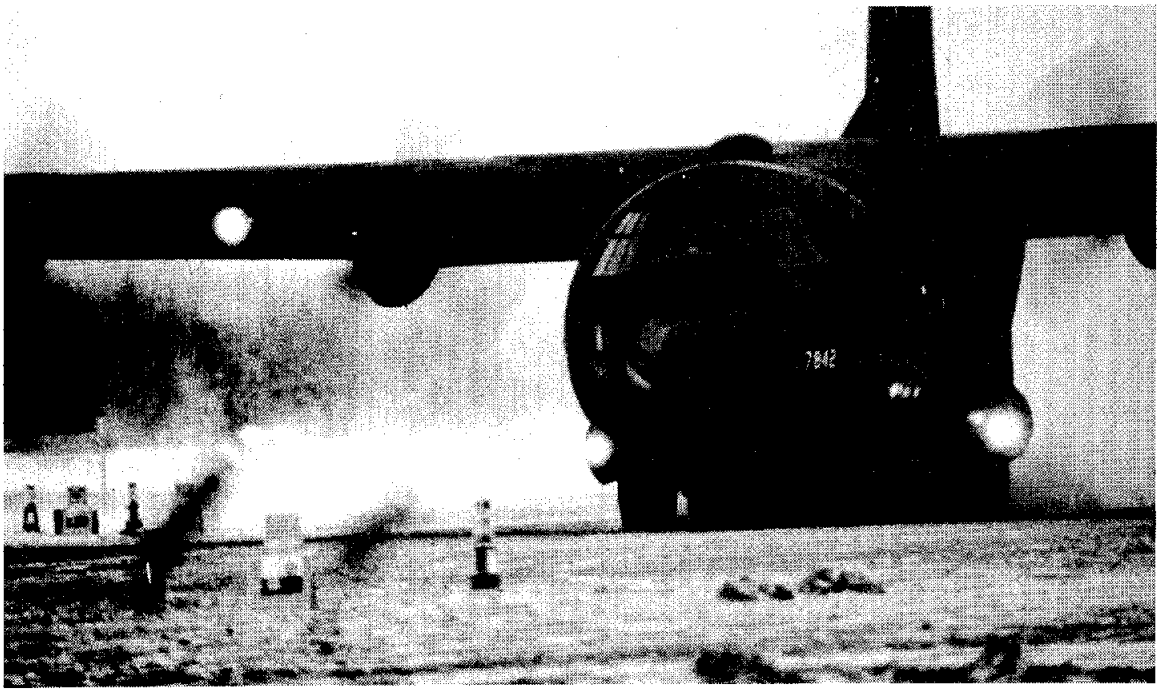
Passive Refrigeration - The Bethel airport primary runway has undergone settlements which were recently repaired using thermal probes to stabilize the subgrade. This research project installed thermistor strings with points every 2.5 feet permanently installed in 3/4 inch I.D. PVC pipe filled with an ethylene glycol-water solution to promote accurate heat transfer without convection loops. These strings are being read every two weeks for analysis by a computer-aided program. The compiled results will hopefully enable future airport and highway projects to be designed to prevent the failure and needed repair which has occurred at this airport.

Radio Isoptope Illuminators - Radio isotope powered fluorescent illuminators have been developed by the U.S. Department of Energy (DOE). A study is being made to assess the potential benefit of such devices for use in rural Alaska for airport lighting. This study also includes an evaluation of Aviator Night Vision Imaging Systems (ANVIS) to be used in conjunction with the illuminators. DOE is performing this work under contract to the Department and a report will be published in the summer of 1983.

This past winter two demonstration projects performed in conjunction with military exercises have been very favorably received by the FAA, the Air National Guard, and the Alaskan Air Command. If successful development of these lights continues, it may be possible to provide airport lights and other landing aids to small rural airports for about 1/5 the capital cost of conventional systems with a similar savings for maintenance and operation costs.



Radioluminescent (R-L) runway lights demonstration for the Federal Aviation Administration and Department of Transportation and Public Facilities in February, 1983.



C130 Hurcules aircraft landing at Clear Creek, Alaska during joint Department of Transportation and Public Facilities/ U.S. Air Force trials of R-L lights.

Remote Airfield Stabilization, Phase I - The scope of this work is to identify, test, and demonstrate cationic asphalt emulsion binder systems with various indigenous soil and aggregate mixes of remote runway surfaces. The purpose is to establish and demonstrate a cost-effective method to improve wind erosion and freeze/thaw resistance of remote runways. These improvements are expected to provide for safer aircraft operations and reduce runway maintenance costs. This work is being performed by Battelle Alaska.

Rural Airport Edge Lighting - This project will develop and install an experimental edge lighting/marker system and study various lighting and reflective marker configurations. The research will include investigating the effects of spacing markers closer together and/or employing different shaped and sized markers than are presently being utilized. Maintenance costs will also be tabulated.

SECTION 3
SPECIAL PROJECTS AND NEW PRODUCTS TESTING

OBJECTIVE

The Research Section responds to inquiries and requests regarding the testing of new products or techniques that could be of value to the Department. These requests come from within the Department, the Legislature, other State agencies, and from the private sector. Some of these requests form the basis of continued research projects that might be funded through the normal budget request cycle, while others require a few hours or days of evaluative effort. Special projects that received funding this fiscal year are summarized in this section.

HIGHWAY RESEARCH PROGRAM

Chem-Crete Asphalt Additive - The report for this project is in preparation at the present time. A summary of the findings of this study are:

1) A rational, literature-backed method was developed for predicting a pavement's load-life potential based on a simple laboratory test procedure.
2) The asphalt additive, Chem-Crete, was evaluated to determine its effectiveness in improving pavement life. It was found that Chem-Crete tended to decrease lifetime load capabilities of pavements from 5% to nearly 20% depending on temperature and asphalt cement grade.

Fabric Reinforced Embankments/Soil Stabilization - Two products are currently being evaluated to determine their effectiveness in stabilizing soils. A private consultant has concluded an anlaysis on fabric materials that may have application in spanning small settlement areas in highways. A test section will be installed during the 1983 winter and monitored during 1984 to evaluate performance.

A second product, an expandable polyethylene grid, may have application in stabilizing sandy soils. If successful, this could have application on airports in the Arctic and along the western coast of Alaska where sources of gravel are in short supply or nonexistent. A report will be available in September, 1983.

Paint Stripe Removal - A new type of paint burner device was purchased and demonstrated in various regions. This unit is designed to remove old traffic paint stripes efficiently with minimal pavement damage. The equipment has been tested, modified with a new type of burner head, and shipped to Anchorage in May, 1983 for further field testing.

Safe-T-Cade Barricades - Safe-T-Cade barricades were purchased, field tested for durability and safety, and distributed to the Maintenance and Operations Section of the Department and to the State Troopers for their familiarization and evaluation. This project was established to make people aware of this new low-cost barricade and only to ask that they consider their use in lieu of rigid frame barricades costing four times as much. These barricades are now being used where applicable.

Freeze/Thaw Tubes for Load Restriction Determination - During the winter, frost heaving can occur beneath Alaska's roadways and airports. Frost heaving is the result of the freezing process in which the freezing soil draws water from underlying unfrozen areas. This results in the formation of ice lenses or layers within the frozen soil. In the springtime as the roadways thaw, large concentrations of excess water from these ice lenses are present in the roadbed. During the thawing period, the road foundation becomes sponge-like and saturated with water, and any heavy truck loads may crack the pavement. For this reason, spring load restrictions are commonly applied to prevent pavement breakup during the critical thawing period.

A simple device called a "freeze/thaw tube" has been built to help determine roadway thaw depth and the corresponding thaw weakening. Small infrared light sources distributed along the side of a piece of PVC pipe are mounted opposite to light sensors and the pipe is buried vertically in the roadway embankment. A transparent tube filled with water is placed in-

inside the PVC pipe. When the water is frozen the ice diffuses the light and the sensor cannot detect it. As the thaw gets deeper and melts the water in the tube, the sensors will detect more and more lights. Work is continuing on these devices.

Operational Testing of Calcium Magnesium Acetate (CMA) - CMA has been identified as a promising noncorrosive substitute for traditional methods of deicing highways. The following tests have been performed:

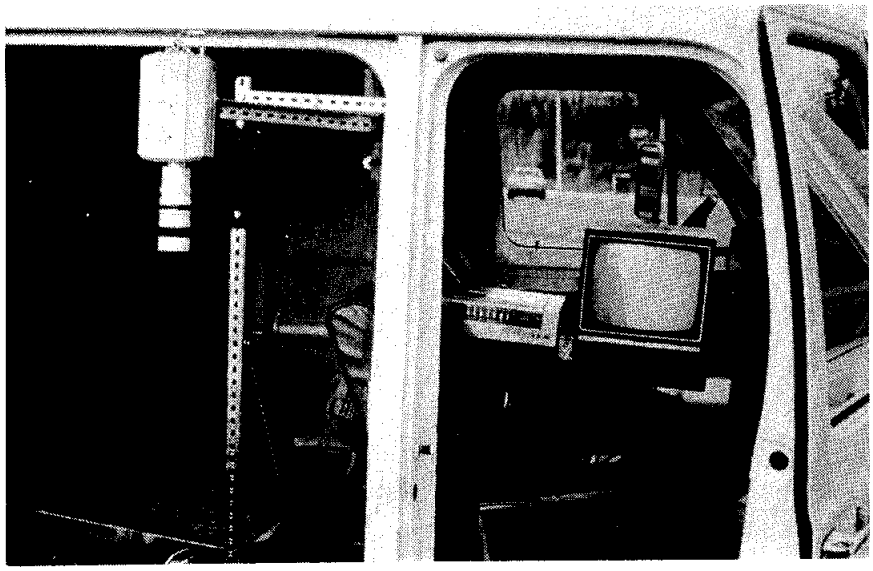
1) two field test applications of locally produced CMA to verify deicing potential;
2) laboratory freeze testing of mortar sand samples treated with various concentrations of CMA and $CaCl_2$ salts to obtain indication of CMA performance in sand stock piles used for winter road maintenance;
3) freeze point depresson test comparing CMA to NaCl (lab study).

A preliminary field test of CMA as a dust palliative was conducted on a gravel surfaced road (Bradway Road in Fairbanks) during the summer, 1983. This test included 100 foot long treatments of the gravel surface with CMA and $CaCl_2$ and will determine whether to continue research on CMA as a dust suppressant.

Winter test section for comparing the deicing effectiveness of calcium chloride, (foreground) and CMA (center).

Montana Asphalt Pooled Fund Study - An interim meeting was recently held in Helena, Montana. A seminar summary was issued which discussed, very briefly, results to date of the High Pressure Liquid Chromatography (HPLC) laboratory testing. Preliminary findings support the original hypothesis that pavement life potential can be assessed by an HPLC measurement of the so-called large molecular size (LMS) fraction characteristic of a particular asphalt cement. Laboratory work is continuing in Montana.

Pavement Rating Using Electronic Imaging - Field work has been completed and approximately two-thirds of the data analyzed. It appears that electronic image analysis of the pavement surface for the purpose of performance measurement will require the use of fast-flash still photography as opposed to the video taping methods used in the study.



Video recording and computerized image analysis are combined for pavement rating experiments.

Portable Soil Sampler - The sampler has been utilized within the context of this study four times. A written critique was prepared by each borrower which outlined specific use of the machine: good points, problems, speed of work compared to more standard methods, and suggestions for improvement. A set of large diameter split spoon samplers has been purchased and will be tested. These samplers replace the smaller, almost unusable ones supplied by the manufacturer. This device is fully portable and shows great potential for low-cost soil investigations at remote sites.

Automatic Hammer for Penetrometer Tests - At the request of the Federal Highway Administration (FHWA), the Central Region geotechnical services unit reviewed its methods of soil and foundation exploration techniques to see what improvements could be made. A new automatic hammer for penetrometer testing was located and funds requested from the Research Section's New Products Testing allocation to evaluate the machine. The evaluation is complete with the following conclusions:

1) The automatic hammer is easy to operate and requires a minimum of instruction time to teach new operators. The old cat-head and rope system required years to develop a skill to operate.
2) There is a minimum of physical labor required to operate the automatic hammer. The cat-head and rope system tended to tire an operator and men often had to trade off when driving the flush-coupled friction penetrometer.
3) The automatic hammer is faster than the old cat-head and rope hammer.
4) The automatic hammer is safe to operate where the old cat-head and rope system was very dangerous and a source of many accidents. The safety feature alone makes this a worthwhile attachment to the drills.
5) The automatic hammer is less costly to operate than the cat-head and rope as there are few parts to wear out.

Seismic Investigation of Riprap Sources - Following the Federal Highway Administration request cited in the Automatic Hammer for Penetrometer Tests project, studies have been initiated to investigate seismic methods for locating riprap sources. In many parts of western Alaska riprap sources are scarce and, when discovered, it is expensive to determine the extent of the supply.

All the necessary seismography equipment has been purchased and prepared for field work later this summer. The equipment appears to be of very good quality and should suit the study well.

ENERGY AND BUILDINGS RESEARCH PROGRAM

Energy Conference - The 4th Annual Alternative Energy Conference was held in Anchorage, January 28-31, 1983. The conference provided a valuable information exchange on a wide range of energy technologies presently in use and newly developed technologies applicable to Alaskan conditions.

Papers were presented by Research Section staff on Heat Exchangers, Building Air Quality, and Use of Passive Solar Additions in Alaska. Partial funding of the conference was provided by the Department.

Solar Room Experimentation - To encourage use of solar energy, the U.S. Department of Energy established a marketable products contract with Solar Resources, Inc. Under the field testing objectives of the contract, Solar Resources, Inc. was able to provide their "Solar Room" product to agencies throughout the U.S. for experimental use in various climates.

The solar room consists of two layers of ultraviolet-inhibited polyethylene ("twin skin") supported over steel tube framing three feet on center. The twin skin is air inflated using a small squirrel cage fan with the inside layer supported by the steel framing and the outer layer supported by air.

The solar room is presently installed on a southern exposure against a double width trailer. Indoor and outdoor temperatures are monitored to evaluate the use of the room under Fairbanks' climatic conditions. Some of the data from the solar room has already been used in the preparation of Report No. AK-RD-82-25, "Use of Sun Spaces in Alaska."

Insulated Shutters - The Research Section has constructed a large-scale Guarded Hot Box conforming to ASTM C 236 specifications for use in testing thermal conduction characteristics of building components. Conduction measurements are possible on items as large as 4 feet by 6 feet over a temperature differential of 100°F. Evaluation of insulated window shutter systems, metal stud walls, and specialty windows are being conducted using this facility. The calibration of instrumentation is complete, and component testing has begun and will continue on an as-needed basis. This equipment is jointly owned and operated by the Department's Research Section and the School of Engineering at the University of Alaska.

PFT Air Exchange Test - Perfluorotetracarbon (PFT) air exchange tests have been made to determine air exchange rates on public buildings and to help calibrate other air exchange testing methods. The project covered three months' testing and analysis on seven buildings. Data analysis is presently underway at Brookhaven National Laboratories. The remaining testing will be done in November or December, 1983. Continuous air exchange rates measured with the PFT samplers are significantly lower than the average of the weekly measurements made using the sulfur hexafluoride gas tracer method. A determination as to the reason for this will be made during the remaining testing.

Lab technician Carol Pederson injects air sample into gas chromatograph to determine building ventilation rate. (Report No. AK-RD-83-32)

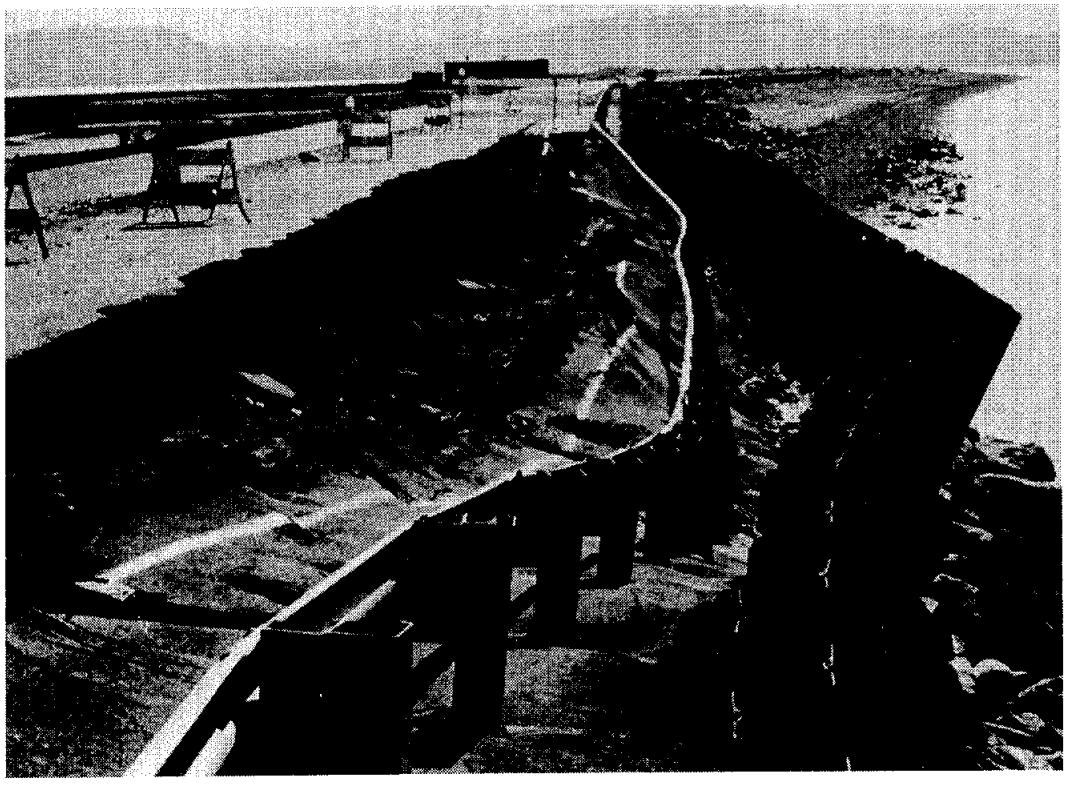
Pulse Light Approach Slope Indicator (PLASI) - The PLASI glide control approach system furnishes a pilot with precise visual approach slope information to provide safe descent guidance. The new PLASI device is expected to have lower annual maintenance and operations costs than the standard Visual Approach Slope Indicator (VASI) system.

A PLASI device was installed at the gravel airstrip next to Lake Hood at the Anchorage International Airport in mid-April, 1981 through mid-October, 1981. The objective of this demonstration was to establish the economics, maintainability, and acceptability of the PLASI versus a VASI. The results of this test are encouraging. During a runway foundation failure problem at the Bethel airport in January, 1982, which rendered the standard slope approach indicator equipment inoperative, the PLASI equipment was installed on an emergency basis. This equipment allowed the continued use of the airport by commercial carriers. Report No. AK-RD-83-17, "Pulsating Light Approach Slope Indicator," describes this project.

Bethel Bump Instrumentation - The Geophysical Institute of the University of Alaska, Fairbanks constructed a device called a freeze-thaw tube for measuring freezing and thawing between airports and highways. This device is designed to determine the depth of freeze or thaw in an embankment by employing light-emitting diodes and photocells to detect the freeze-thaw interface of the water contained within the tube. One tube was installed with a thermopile being placed under the Bethel airport runway and will be used to provide information regarding the technical performance of the pile. Implementation is complete and data is now being collected to evaluate the temperature characteristics of the airport foundation.

Screw Pile Foundation Supports - A project is being conducted to determine whether screw piles can be placed by hand methods to depths adequate for resisting vertical and horizontal loads imposed by small supported structures. The anticipated benefit of this project is the development of a low cost foundation system that can be placed by local labor in most of rural Alaska.

Erosion Control Products - This project is examining the design, construction procedures, and performance of two erosion control products, ARMORFLEX and ARMORFORM. The study will also evaluate the practical and economical feasibility of these two systems as alternatives for coast and streambank protection where riprap is not available.



Damaged highway section on the Homer Spit. (Report No. AK-RD-83-24)

Sand Confinement Grid Evaluation - The Aviation Section of the Department has experienced problems building airfields in remote parts of Alaska where suitable foundation materials are in short supply. Because of these problems, the Research Section has begun studying a plastic sand confinement grid which provides structural strength of fine grained materials by enclosing them in a grid. These sand confinement grids have been extensively studied by the Corps of Engineers at the Waterways Experiment Station in Vicksburg, Mississippi. Both highway roadbed and airfield tests have been made with success. Plans are underway to utilize this technique at a new airport in Shishmaref on the western coast of Alaska. A report will be available in the fall of 1983.

Sand confinement grids similar to these are planned for the new Shishmaref airport.

South Central Alaska Seismic Profile - Late in the fall of 1982 seismologists at the U.S. Geological Survey, Menlo Park, California, and the Geophysical Institute of the University of Alaska became aware of large explosions being planned for a highway project near Anchorage. These explosions were significant enough to give seismologists meaningful data on a refraction profile from Hatcher Pass to Seward. Data had not been obtained for this area since the 1964 earthquake. By the time the plans for the explosions were discovered, only two large detonations remained scheduled. A project was quickly put together involving the following agencies:

1. U.S. Geological Survey, (USGS), Menlo Park, California
2. Geophysical Institute, University of Alaska, (UAGI)
3. Division of Geological and Geophysical Survey, (DGGS), Fairbanks
4. Alaska Tsunami Warning Center, Palmer
5. Research Section, Department of Transportation and Public Facilities

The USGS deployed stations along the Seward Highway south of the site while the DGGS and the Geophysical Institute deployed instruments to the north of the blast site. The Tsunami Warning Center provided logistic support facilities and special recording of the stations deployed by UAGI and DGGS. The Research Section provided financial support to the University and acted as a liaison between the scientists in the field and the contractor at the blast site.

About 16 temporary stations were established, eight to the south and eight to the north of the blast site. Sharp and clear arrivals were recorded at about ten of these stations as well as at several of the permanent stations. These data are now being analyzed. Preliminary results show that significant adjustments will be made to the velocity model for the Kenai Peninsula as a result of information gained by this experiment.

An important aspect of this project is that with quick coordination between several agencies the state gained important seismic information utilizing routine highway blasting. In the future, attempts will be made by the Research Section to inform other agencies regarding such blasting.

SECTION 4
IMPLEMENTATION

OBJECTIVE

The end product of applied research and development is implementation into everyday use. Listed in this section are the results of research projects that have changed previous practices or made other positive contributions.

HIGHWAY RESEARCH PROGRAM

Annual Highway Condition Surveys

Annual road condition surveys are performed and pavements needing repair are identified by means of a rating method developed by the Research Section. This information has been compiled annually by the Research Section since 1978. The purchase and use of a new Falling Weight Deflectometer (FWD) pavement strength testing device gives deflection data on a volume basis to:

1. provide information on when to set and remove load restrictions;
2. provide input data for current pavement design procedures;
3. point out probable problem areas due to weak pavement structure, and;
4. estimate remaining pavement life.

Report No. AK-RD-83-11, "Prediction of Damage Potential on Alaskan Highways During Spring Thaw Using the Falling Weight Deflectometer" resulted from this work.

Additional reports being written are "Structural Evaluation Of and Overlay Design for Runway 6L/24R Using the Falling Weight Deflectometer" and "Glenn Highway Overlay Design Using the Falling Weight Deflectometer."

Falling Weight Deflectometer used to test roadway strength.
(Report No. AK-RD-83-11)

Engineering Computer Software

Engineering computer software packages have been installed on the Boeing Computer System which provided various earthwork computer techniques to engineers in all regions. The projects designed since 1982 have used this package, thereby reducing design time while improving the final product. A report documenting this work is being prepared.

Air Duct Permafrost Stabilization Systems

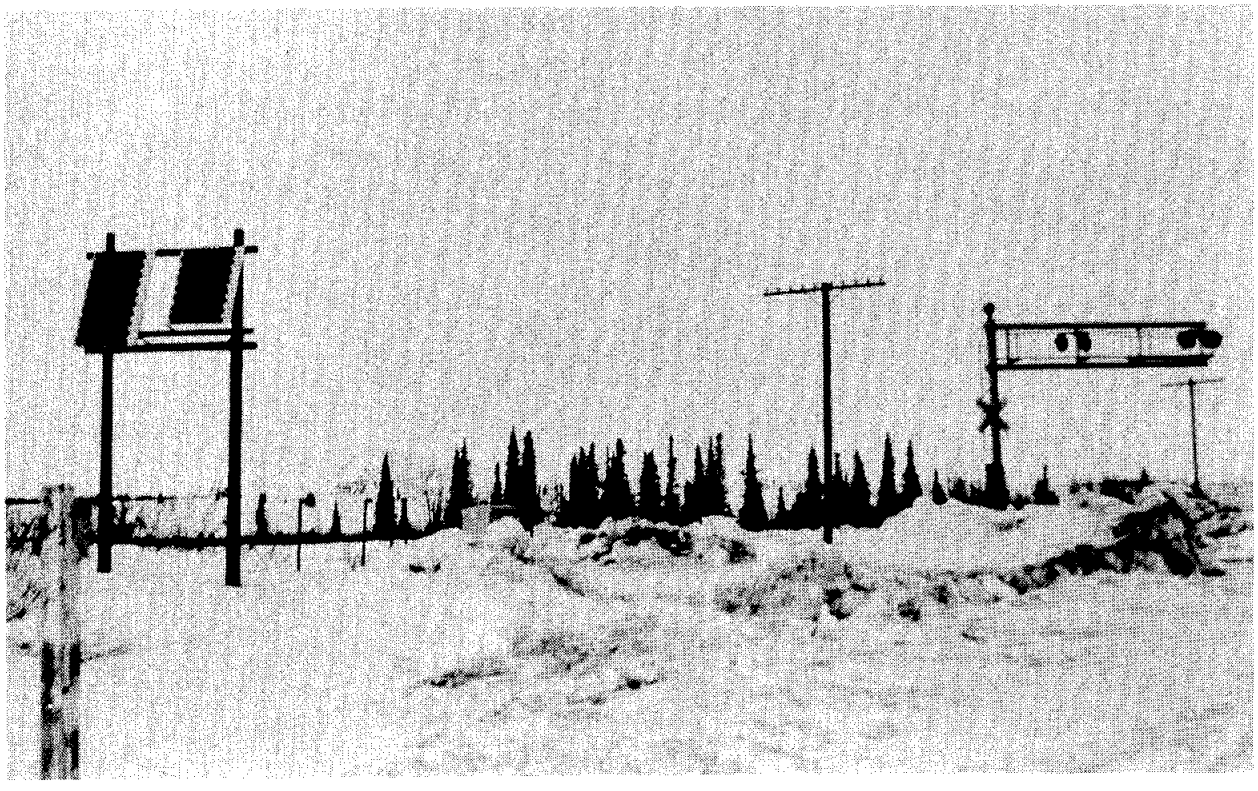
A system using corrugated pipes designed to remove heat and refreeze thawed permafrost soils each winter by natural convective heat flow was installed on the Alaska Highway near Northway in July of 1983. This installation, used to prevent roadway slope movements, was designed based on experimental installations near Fairbanks made in 1975. Work is continuing on improving this design technique. Reports entitled "Road Embankment Design Alternatives over Permafrost" (1978) and "Air Duct Systems for Roadway Stabilization over Permafrost Areas" (1983) describe this system. (Report No. AK-RD-84-01)

Portable Permafrost Probe System

Developed in early 1981, a permafrost probing system was successfully used for thaw depth probing beneath roadways and building foundations. Depths of 30 feet can be reached using only an 8 pound, 1/2-inch impact drill with threaded steel drive rods of a special design. The probe rods can be withdrawn by manual effort only. This work is described in Report FHWA-AK-RD-83-12, "Portable Powered Probe for Permafrost." This system is extremely simple and low in cost and will benefit all those who want to explore building sites for the presence of permafrost.

Solar Energy for Highway and Railroad Use

A solar energy system was designed, constructed, and installed as an alternative energy source for powering flasher signals at a highway/railroad grade crossing in a remote area. The system is nearly maintenance-free, more cost-effective than the system it replaced, and should be considered as a viable energy source at remote locations. As a result of this study, the Alaska Railroad has installed similar solar energy systems at three additional remote locations to furnish energy for signals at highway/railroad crossings and at three microwave repeater locations as a part of their communication system. Railroad personnel report satisfactory operation for all of the six additional installations. This study will result in an estimated $406,105 savings for the seven systems over the next 21 years. A report has been published, FHWA-AK-RD-83-13, "Solar Energy for Highway Uses."



Solar energy system at Summit, Alaska. (Report No. AK-RD-83-13)

Economic Aspects of High Speed Gravel Roads

This project produced necessary information regarding:

1. design and maintenance requirements of improved gravel-surfaced roads (i.e. safe for travel at high speeds);
2. costs of the above as a function of foundation soil type and terrain;
3. comparative costs and requirements for equivalent paved roads.

The information is being used to provide improved service on gravel-surfaced roads in a cost-effective manner and in deciding when and if paving of roads is warranted. It was determined, for example, that gravel roads treated regularly with dust control/cementing agents can provide adequate service for much less money than paved roads where the roadway structure is weak or the foundation is thaw-unstable permafrost, but that paved roads are more cost-effective where better foundation material exists. The results are detailed in Report No. FHWA-AK-RD-83-20, "Economic Aspects of High Speed Gravel Roads."

Thermoplastic Striping

A study has recently been completed which addresses the failures of thermoplastic striping on highways. The report recommends changes in specifications, materials selection, and construction techniques. These recommendations will be incorporated into all future projects using thermoplastic striping. A report entitled "Performance of Thermoplastic Striping in Alaska," FHWA-AK-RD-83-22, has been published.

Permafrost and Ice Detection Research

Techniques developed using ground resistivity measurements have minimized the need for test borings at three potential airfield sites in 1982. The method has also been applied to located bedrock at two sites in 1982. This technique is used to improve site selections of airports and roads and avoid long-term maintenance problems. The report which was written describing these methods is AK-RD-83-27, "Field Evaluation Site for Ground Ice Detection - Final Report."

Non-contact soil resistivity test device to detect permafrost and ground ice. (Report No. AK-RD-83-27)

Modern Pavement Design Methods and Pavement Life Cost Modeling

These recently completed studies have provided a rational basis for analyzing pavement structures based on their basic elastic properties. Our pavement life predictions are presently made by applying deflection measurements to models derived from this research. Basic pavement design analyses are presented in FHWA-AK-RD-83-8, "Use of Layered Theory in the Design and Evaluation of Pavement Systems." This report provides technical background and also serves as a user's manual for a series of five computer programs. Life cycle costing is covered by a two-volume report set, AK-RD-83-5, "Life Cycle Costing of Paved Alaskan Highways, Volume I" and AK-RD-83-6, "Life Cycle Costing of Paved Alaskan Highways - User Manual." Volume I describes the system and the user's manual is a computer program.

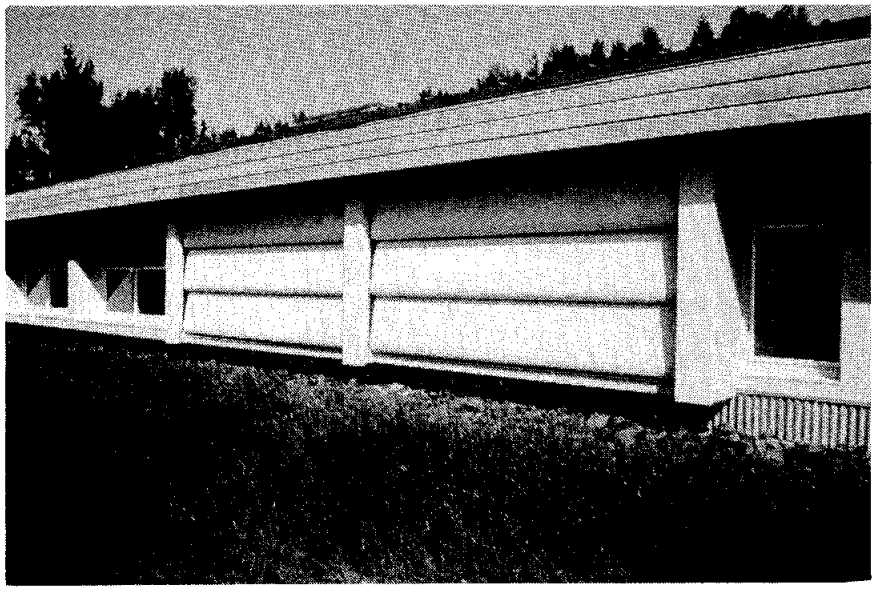
Bush Fire Protection

The incidence of fire in bush Alaska is among the nation's highest. Traditional water sprinkler fire protection systems for bush area institutional buildings are expensive to install and maintain, especially in areas without utility water, a common occurrence in many locations. When activated needlessly or to control a very minor fire, sprinkler systems can cause tremendous damage to buildings and their contents, especially during the winter months. Sprinklers are also vulnerable to freeze damage and other problems if not properly maintained, possibly leaving the structure damaged by water and/or unprotected.

This project demonstrated that an industrial Halon 1301 Gaseous Fire Suppression System can be modified for institutional/-residential use as a viable alternative to the water sprinkler system. The system was installed in a Bethel, Alaska hostel for approximately the same price as a water system and has now undergone a year of monitoring. The system appears to offer the same level of protection as water with much lower maintenance. In comparison to water sprinkler systems, Halon does not risk structural damage and greatly reduces downtime should the system be activated. Refer to interim Report No. AK-RD-82-5, "Halon Fire Suppression System Demonstration for the Alaskan Bush."

Automatic Window Shutter Systems

The use of direct-gain, southern exposure glazing with an automatic controlled window shuttering system was demonstrated in the construction of a state-funded school (Two Rivers Elementary School near Fairbanks). Since the Two Rivers School solar features were first presented at the annual convention of the Alaska Chapter of the American Institute of Architects in November, 1981, several other state schools now in the planning stages are incorporating similar systems in their designs.



Automatically controlled shutters installed on one classroom of the Two Rivers School.

Building Air Quality

Considerable information has been gained regarding air exchange rates in buildings. These measurement techniques have been used in the State Courthouse in Fairbanks to determine the design of improvements in the building's inadequate ventilation system. The testing has also provided information about air-flow patterns in the Fairbanks Memorial Hospital. The results are being used to minimize the risk of infectious disease transmittance within the Intensive Care Unit. Report No. AK-RD-83-33, "Air Flow in Fairbanks Memorial Hospital Intensive Care Unit" describes this investigation.

Building Energy Analysis System

Public facility planners and design managers now utilize a computer program entitled "F-LOAD." This program on the University of Alaska Honeywell computer network can be accessed by all regions of the Department. F-LOAD is an interactive program that calculates the heating load of residential or light commercial/institutional buildings. A unique feature of the program incorporates passive solar design analysis. This feature permits quick comparison of various designs to evaluate the potential energy efficiency of a new building at the specific location. By evaluating several alternatives in the preliminary stages of design development, more energy conservative approaches can be identified and followed throughout the entire process.

Workshops were held for general design and construction and public facility planning employees in Anchorage, Fairbanks, and Juneau to give them hands-on experience in the use of the program. Manuals were distributed to all regions for future reference. Implementation of the use of this computer technique into routine operation is resulting in significant long-term energy savings and lower life cycle costs for the operation of state buildings.

Alaskan Thermal Performance Standards

Mandated by the Alaska Legislature in 1980, the development of acceptable thermal performance and lighting energy standards for state buildings has been a major project for the Energy and Buildings research program for the past three years. At the present time, three project reports have been published and the standards document is in final draft. Full implementation of the standard will not be complete for another year but should result in significant long-term savings to the state. The reports published to date are:

AK-RD-81-19, "A Thermal Performance Design Optimization Study for Small Alaskan Rural Schools" (Interim Report)

AK-RD-83-2, "A Thermal Performance Design Optimization Study for Small Alaskan Rural Schools"

AK-RD-83-3, "Thermal and Cost Analysis of Thermal Envelopes for a Small Rural School"

Building Freeze Alarms

Radio-based alarm units have been developed for installation in unattended buildings which require monitoring against unintentional freeze-ups. These simple alarms were designed to alert maintenance personnel to abnormally low building temperatures prior to freeze-up so building and content damage can be substantially reduced, if not eliminated. The alarms are small, self-contained devices which can be easily installed in existing buildings and are capable of transmitting an alarm signal via low power VHF radio to portable pager units located up to seven miles away. Cold temperature, transmitter range, and operational tests have been performed on three prototype units with good success. One unit has been installed recently in a Barrow airport maintenance shop which frequently experiences heating unit failures, to the detriment of a water-filled truck which is stored inside.

Arrangements are now underway to secure a Federal Communications Commission (FCC) license for ten temporary units. After deployment of the units on the temporary license, application for a permanent station house will then be processed. Further information concerning design specifications and test results are available from the Research Section in two reports, AK-RD-83-10, "Design Report - Building Freeze Alarm System" and AK-RD-83-25, "Test Report - Building Freeze Alarm Systems."

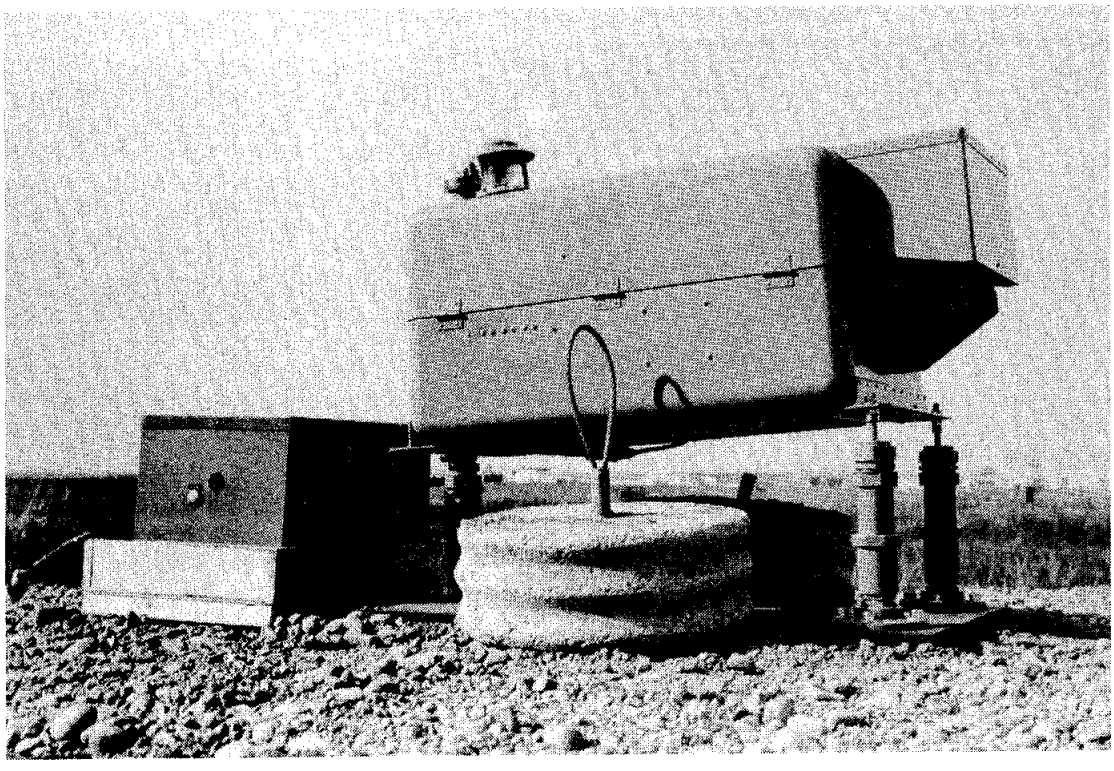
Meteor Burst Telemetry Demonstration

The State of Alaska has a verifiable need for low-cost, reliable, real-time communication to and from rural areas. Some of these telemetry tasks, such as the remote aviation weather monitoring system, are now being implemented with the use of what is called meteor burst communication technology. Computer technology now makes it possible and feasible to transfer bursts of digital information between stations separated by up to 1,200 miles by scattering VHF radio signals off meteor trails which frequent the upper atmosphere. While meteor burst is now primarily being utilized in the acquisition of meteorological and scientific data, this field study has demonstrated that practically any scheme involving low data rate information retrival could profit from its use.

The Department's demonstration project for evaluating the feasibility of meteor burst technology in state applications is reported in two publications entitled "Low Data Rate Digital Transmission Techniques for Alaskan Applications" (Report No. AK-RD-81-6) and "Meteor Burst Demonstration Project--Interim Report" (Report No. AK-RD-82-4). The program's final report, "Monitoring the Operation of a Remote Facility Using Meteor Burst Telemetry," is scheduled for completion in the fall of 1983.

Pulse Light Approach Slope Indicator (PLASI)

As a result of a six-month test in Anchorage, a PLASI was used at the Bethel airport as an interim solution to an emergency situation that occurred in January, 1982 when a "dip" developed within the threshold of the runway, rendering the Visual Approach Slope Indicator (VASI) unusable because of the displaced threshold. Tentative plans are also being made to install PLASI's at several rural airports because of the favorable economics and ease of maintenance exhibited during the test period. Refer to Report No. AK-RD-83-17, "Pulse Light Approach Slope Indicator."



Plasi Light Approach Slope Indicator (PLASI) glide control system at the Bethel airport. (Report No. AK-RD-83-17)

Fairbanks Traffic System Research

This project first involved recommendations for changes to certain components of the Fairbanks traffic control system in order to improve the efficiency. Based on these recommendations, a demonstration project evolved resulting in construction work currently scheduled for completion during early summer 1983. A final report will be issued at the end of the demonstration phase.

Bridge Deck Corrosion and Bridge Deck Repair Techniques

A bridge deck corrosion study has shown that there are many bridge decks in the state that need repair due to corrosion caused by the use of chloride salts as deicing agents. Reports are currently being prepared to help in the design and construction of future projects as well as in the repair of existing bridges.

Cushman Street Bridge deck repairs being made as a result of corrosion and caused by the use of deicing salt. (Report No. AK-RD-83-35)

The test data gathered indicated that the reinforcing steel in four Fairbanks area bridges was corroding and needed to be repaired to prevent premature replacement of the bridges. Those structures have been repaired using two different techniques. On three of the bridges the unsound concrete was removed and then overlaid with latex-modified concrete. The latex-modified concrete is designed to act as a moisture membrane and will slow down the corrosion process. The technique used on the other bridge utilized cathodic protection as well as latex-modified concrete overlay. This system is more expensive, but it is designed to stop corrosion completely. These two methods are being compared and their cost-effectiveness will be evaluated. Report No. AK-RD-83-35, "Bridge Deck Repair Techniques," details this work.

Paint Performance Testing

In the past, the Division of Maintenance and Operations utilized traffic paint specifications which detailed the composition of paint to be qualified under Department bid specifications. It was found, however, that these specifications do not always determine the durability of the paint. The purpose of this testing was to develop a bid procedure where the major criteria is the durability of the paint in order to reduce the cost of traffic painting. This work was performed by Woodward-Clyde Consultants and new specifications have been adopted as a result of this study. Refer to Report No. AK-RD-83-28, "Paint Performance Testing."

Testing highway traffic striping paint for durability.
(Report No. AK-RD-83-28)

Design Criteria for Driven Piles

This study was a review of existing driven pile technology by consultant Peratrovich, Nottingham and Drage, Inc. A design guide was developed which can be applied directly to arctic or permafrost foundation installations and is currently being utilized by Department designers. Refer to Report No. AK-RD-83-19, "Design Criteria for Driven Piles in Permafrost."

Corrosion Research and Recommendations

This work was an analysis for the Alaska marine environment of existing corrosion information in order to develop specific recommendations for future design applications. The project was performed by consultant Peratrovich, Nottingham and Drage, Inc. Refer to Report No. AK-RD-83-26, "Corrosion in the Alaska Marine Environment, Research and Recommendations." As a result of the information presented by the field inspections, several problem areas were flagged and preventative maintenance has been accelerated in those areas.

Alternative Transportation Modals

This demonstration utilized a 160-passenger Boeing Jetfoil to study the capability of hydrofoil operation at ports in Southeast Alaska. The project ran for two periods: summer from mid-August to mid-September, 1982 and winter from mid-January to mid-February, 1983. Approximately 225 hours of ship time were provided. Costs of operations and feasibility of the craft were assessed during the demonstration, performed by The Boeing Company. Refer to the report entitled "A Study of Public Attitudes Toward the Jetfoil in Southeast Alaska" accomplished by Gilmore Research Group. A final report is currently being written. Based on this project, a decision on the future use of hydrofoils as a commuter craft in Southeast Alaska will be made.

Aircraft Hydroplaning Prevention

Aircraft accidents attributed to the hydroplaning phenomena are of major national concern. The Federal Aviation Administration has embarked on a program to have at least one runway at each air carrier airport served by jet transports to be either grooved or have a porous friction course (PFC) surface. To date, there has not been adequate study of these preventive measures against hydroplaning in an arctic environment. This project studied these techniques and documented the need for hydroplaning prevention measures, as well as estimating the effects in terms of additional user costs of runway design, construction, and maintenance alternatives. Two different hydroplaning prevention techniques were incorporated into the Kodiak airport runway as a result of this project. A report of the findings will be issued in mid-November, 1983.

Automated Weather Reporting Demonstration

An Automated Weather Observing System (AWOS), which will automatically acquire, process, and disseminate aviation weather observations, was studied as the initial phase of this project. The system information included wind speed and direction, temperature, dew point, precipitation occurrence and quantity, altimeter setting, visibility, cloud height and ceiling, density, altitude, time, and airport identification. A follow-on phase of this project is being performed by the FAA under contract to the Department. AWOS equipment funded by the Department will be located at Galena where manned weather observations will be compared with AWOS data to verify accuracy and pilot acceptance of the automated system. Two other sites funded by the FAA will be located at Farewell and Valdez. These sites using equipment from three different manufacturers will allow for complete assessment of feasibility of these systems.

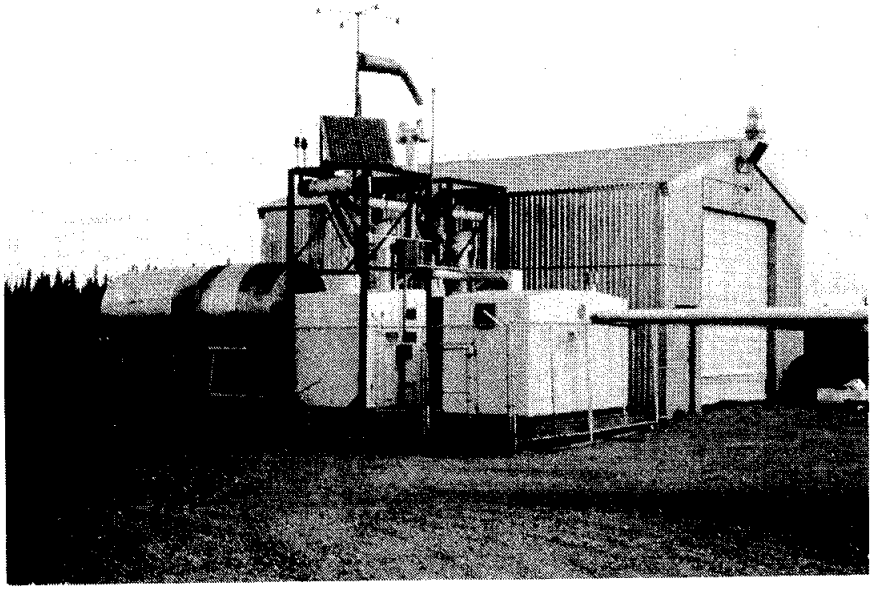
Noorvik Airport Lighting Demonstration

During the summer and fall of 1979 a research project was conducted to identify and develop a highly reliable, low maintenance electric power supply system as an appropriate alternative to the diesel-electric generator for powering runway lighting systems at rural Alaskan airports. This project, defined in a research report entitled "Remote Airport Lighting Systems Feasibility Report and Design Guide," recommended an organic Rankine cycle turbo-electric generator and a large battery bank as primary components. The major advantages of this system are its high reliability, minimal maintenance requirements, and relatively long life (20 years).

In early October, 1980 a Federal Aviation Administration (FAA) approved runway lighting system was installed at the Noorvik Airport using village-supplied electricity as the power source. In late March, 1981 two Ormat organic Rankine cycle generators were installed. This project provided a demonstration for comparison of reliability and costs of both power sources and was

completed in April, 1982. The turbines proved to be a highly reliable, low maintenance electric power supply and are recommended for use to provide runway lighting at rural airports where local power is not available. Refer to Report No. AK-RD-83-18, "The Demonstration at Noorvik of an Unattended, Pilot Operated Airport Lighting System."

Previous to the installation of FAA approved lights, Noorvik used the "firepot" technique for emergency lighting. The new lights are turned on and controlled by the pilot of an incoming aircraft and remain lit for 15 minutes.



Demonstration of two closed cycle vapor turbine generators for supplying power to a standard FAA airport lighting system at Noorvik. (Report No. AK-RD-83-28)

SECTION 5

PUBLICATIONS

On the following pages are listed the publications produced by the Research Section since July 1, 1980. The asterisk indicates reports no longer available through the Research Section but available at state libraries. In addition, most publications are kept on microfiche at the:

Arctic Environmental Information and Data Center
University of Alaska
707 A Street
Anchorage, Alaska 99501
(907) 279-4523

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AK-RD-80-2	Wentink, T., Alaska Wind Power User's Manual, 1st Edition, 101 pp., 1980.
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AK-RD-80-6	Roberts, T.D., R.P. Merritt, and K.J. Kokjer, Low Data Rate Digital Transmission Techniques for Alaskan Applications, 31 pp., 1981.
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FHWA-AK-RD-81-08	Connor, B., Rational Seasonal Load Restrictions and Overload Permits, 52 pp., 1980.
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April 1983, Volume 2, Number 10, Steve Powers.

HIGHWAY SUBSIDENCE FROM MELTING PERMAFROST
May 1983, Volume 2, Number 11, Larry Sweet.

SOLAR THAWING OF PERMAFROST
June 1983, Volume 2, Number 10, David Esch.

AIRPORT LIGHTING FOR RURAL ALASKA
July 1983, Volume 3, Number 1, Lee Leonard

PROGRESS IN ALASKAN PAVEMENT DESIGN
August 1983, Volume 3, Number 2, Robert L. McHattie

SECTION 6

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A special acknowledgement is extended to Mr. H. "Glen" Glenzer, Deputy Commissioner, Northern Region for his efforts in helping implement the results of our research projects. In the short time he has been with the Department, his understanding of the necessary function of research has been felt and appreciated by the Research staff.

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